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FOUNDRY TRADE JOURNAL
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THE MOST MOMENTOUS CONGRESS EVER HELD TO DISCUSS FOUNDRY AFFAIRS

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The Editor looks back at Earlier Congresses and Examines the Current Programme

Unique in the field of international technical co-operation is the International Committee of Foundry Technical Associations. It is the 22nd occasion that this body is meeting, this year at the invitation of the Institute of British Foundrymen. Generally accepted is the fact that this Committee was created at a meeting of the presidents of the Belgian, British, French and German foundry technical associations held in Brussels in 1926. Yet this was not the genesis of such co-operation. There was a visit by the president of the American Foundrymen's Association to this country in 1920 and as a result the first Exchange Paper was received from America and read at the Blackpool conference in 1921. During the next few years, there were so-called international foundry exhibitions in Birmingham and Paris, with important but limited foreign participation. Thus, it was one of the objects of the Brussels meeting to create order out of what looked like becoming chaos. Perhaps originally too much logic was injected into scheduled programmes of congresses. They were to be of two types—designated A and B, one of which was to be favoured with American participation, and the second without such co-operation. Since the last war, the rota system has given place to invitation by the various national associations—a much more satisfactory scheme.

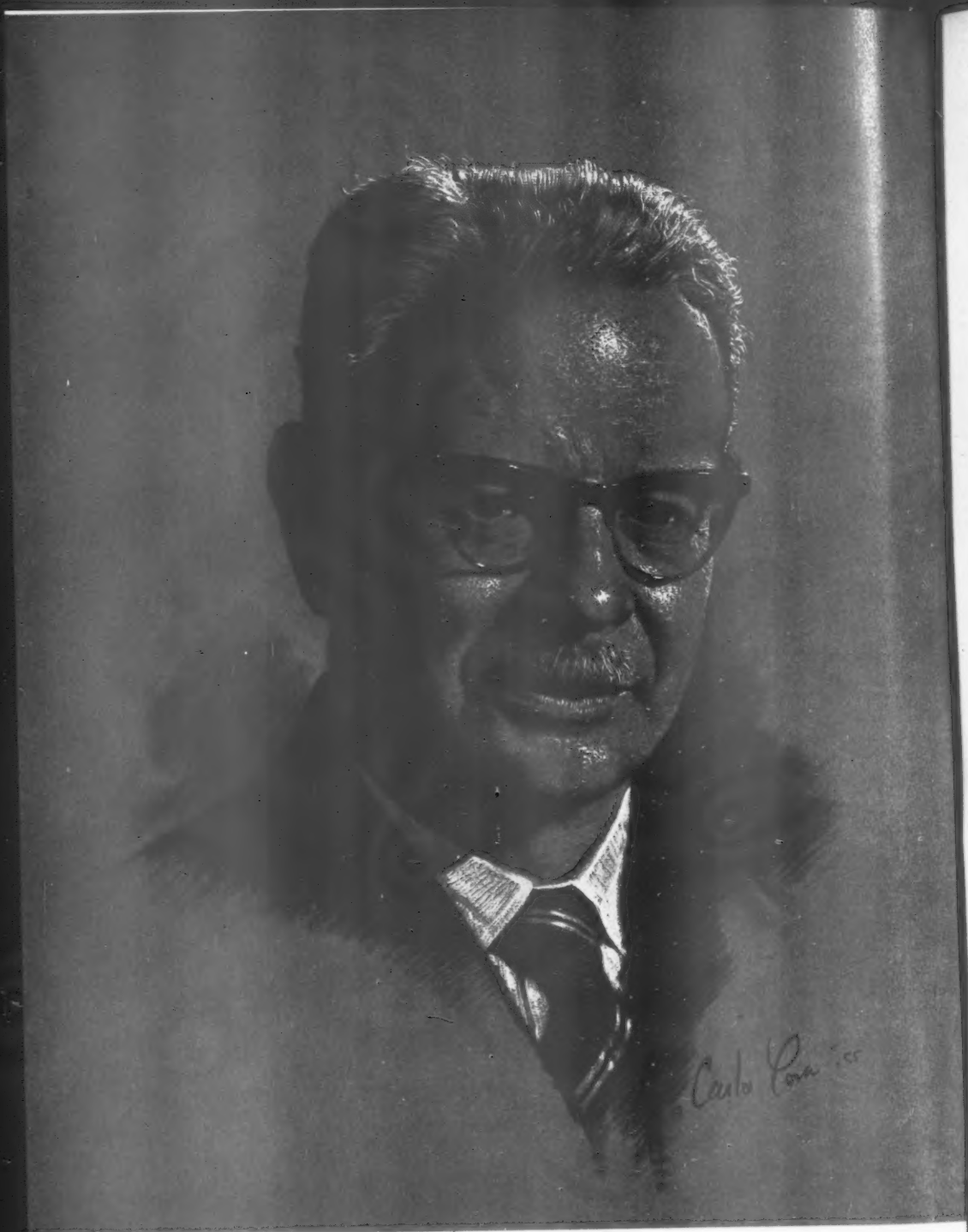
The original four European foundry associations from which the presidents were chosen has grown. America quickly became associated with the movement and then came Italy, the Netherlands, Czechoslovakia, Poland, Spain and Austria. Some of these are no longer members, but now Switzerland, Norway, Sweden, Denmark, India, Finland and Japan have joined up. There have been congresses in the United States, Paris, London, Belgium, Prague, Italy, Poland, Barcelona, Amsterdam, Dusseldorf, and sometimes more than one.

This year's event is the third time an International Foundry Congress has been held in London. The first was in 1929 when the late Mr. Wesley Lambert, C.B.E., presided. There was a reception at the Guildhall, when the Lord Mayor personally welcomed the delegates and there were replies from each country represented. This time-wasting system has since been replaced by one through which the President of the International Committee speaks for everybody. The Congress banquet was held at the now defunct Hotel Cecil, when there was a large delegation of American foundrymen. On this occasion, there was a pre- and not post-congress tour, a system which has a certain amount of merit. Moreover, there was staged a foundry-equipment exhibition as an added attraction.

The next Congress to be held in London was in 1939 at a time when the clouds of war were rapidly gathering. The late Mr. W. B. Lake was president of the Institute and Dr. Guido Vanzetti the president of the International Committee. Despite the shadow of war, the Congress was an unqualified success. The Edward Williams Lecture was given by Sir Lawrence Bragg and was exceptionally well received. He has the gift of making abstruse subjects appear to be really quite simple. This year's Congress will be, if careful organization and cordial industrial co-operation are governing factors, an outstanding social success. As for the technical contributions, these are in the main overseas exchange papers and in the aggregate can be considered of the kind which are of major interest to world foundry thought. Yet we doubt if all will be to the taste of that large body of technicians designated as being of the practical type. There are some outstanding practical papers however, and these will be the major source of discussion, as they cover recent developments, and theory is made the real handmaiden of practice.

The list of social events is both extensive and diversified. The restful atmosphere of a garden party, or a trip up the River contrasts markedly with a cabaret show or a sightseeing tour of London. The closing banquet in the Dorchester's modern setting will make an entirely different appeal from that provided by the receptions in the dignified apartments of the Fishmongers' Hall or Lancaster House. Again, what could be more different than a mannequin parade and a visit to the Royal Mint. The net has indeed been cast wide.

The visits to the various foundries again show wide variations not only in type of manufacture but also in their locations. They are situated along the banks of the great rivers, in model villages, or surrounded by poor-class dwellings. Such is the present-day set-up of industrial Britain. The character can be well gauged from the extensive section of this issue of the JOURNAL which has been devoted to their description and illustration. Most of them are large by European standards, but their methods and equipment have had a profound influence upon the smaller concerns.



A. B. EVEREST, Ph.D., F.I.M.

President-designate of the Institute of British Foundrymen

President-designate

A. B. EVEREST

FOR the past 28 years, Dr. Everest has been known for his work on the development of alloy and special cast irons. His interest in metals, however, dates back to his schooldays, when he made metallography one of his hobbies, and studied metallurgy under the guidance of the late Mr. W. B. Parker of the British Thomson-Houston Company, Limited. On leaving school, he trained in the laboratories of the B.T.H., where every aspect of the materials used in a large electrical engineering works was covered, including foundry control, and the day-to-day testing and checking of castings of all kinds. His apprenticeship then included periods in the drawing offices, machine-shops, and finally the light and heavy iron foundries. Here his experience ranged from the production of small jobbing castings to working as a member of the team on large steam-turbine casings and electrical machinery frames. During this period he gained experience, at floor level, not only of ironfoundry practice, but also of working together with craftsmen on the job.

After graduating at Birmingham University, Everest had the opportunity of taking up metallurgical research. In his choice of subject, he was guided by the late Mr. Parker, who foresaw great potentialities in cast iron, and he followed his advice in studying aluminium in cast iron, in the hope of finding castings with improved strength and heat-resistance, to meet the increasingly severe demands of engineering practice.

In his researches at Birmingham, under Professor T. Turner and Professor D. Hanson, Dr. Everest worked closely with the British Cast Iron Research Association, and through the help of Dr. J. G. Pearce, F. J. Cook and other pioneers, he was able to carry out works-scale experiments in several leading Midlands foundries. He left his mark not only as holes in one foundry roof—as a result of too violent a reaction when aluminium was added to a ladle of iron under abnormal conditions—but in the form of fluidity and shrinkage tests, and a calibrated ladle known as the Everest ladle, used for years in one leading automobile foundry.

Since those days, Everest has devoted most of his time to the development of high-duty cast iron through his activities in the Development and Research Department of the Mond Nickel Company, Limited. It has been a rewarding and exciting era, with the strength of cast iron progressively rising from 20 up to 60 tons per sq. in. or more. He has built up an international reputation and is an acknowledged authority on cast iron, and through his lectures and papers is known to engineers and foundrymen throughout Europe and the USA.

Commencing in 1926, Everest has been closely associated with the Institute of British Foundrymen, and has served for almost a quarter of a century on its Council and Technical Committees. His work for the foundry industry has been recognized by Institute Diplomas, the Oliver Stubbs gold medal, and also by the Gold Medal of the French Foundrymen's Association. He represents the Institute and industry on both national and international committees, and for several years was examiner in foundry practice in the Institution of Metallurgists.

The Institute of British Foundrymen

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W.C. Faulkner, Esq., F.R.S.A., Hon.M.I.B.F.,
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Foundry Trade Journal,
John Adam House,
Adelphi, London, W.C.2.

Dear Mr. Faulkner,

WELCOME TO THE CONGRESS

On behalf of the whole membership of the Institute of British Foundrymen, I would like to record in the pages of your special issue a very hearty welcome to all the participants in the International Foundry Congress and the 52nd Annual Conference of the Institute, their ladies, and especially delegates and ladies from overseas.

The programme of technical papers, works visits and social functions for the week in London and the two post-Congress tours offers a wide variety of choice to suit every taste. It is hoped it will be enjoyed to the full by all, and that good weather, friendly deliberations and social intercourse will grace our meetings. The Congress has been arranged by numerous painstaking committees of which I have had the honour to be chairman apart from the ladies committee which was presided over by Mrs. Everest, and I take this opportunity of making public the Institute's indebtedness to those who have served in this way or otherwise helped in the organization, which has gone ahead so smoothly. A special word of thanks is due to our joint secretaries G. Lambert and W.G. Mochrie.

Finally, I give personal thanks for such willing assistance from so many people, not least among whom I include those executives of the forty works who will be "At Home" to the visitors, and the head-office staff who have worked so hard for so long to make the Congress a success.

Yours sincerely,

A. B. EVEREST
President Designate and Chairman
of the Organizing Committee.

International Foundry Congress

London, June 19 to 25 and Post-Congress Tours, June 26 to July 2

The completed programme for the June International Foundry Congress organized by the Institute of British Foundrymen (under the auspices of the International Committee of Foundry Technical Associations) is printed in detail below. The main conference week begins with an informal Garden Party on Sunday, June 19, at the Harrow home of Mr. and Mrs. Barrington Hooper and concludes on Saturday, June 25, with an all-day trip to Blenheim Palace, Oxfordshire. In between, each minute of delegates' working time can be employed in committee, at technical sessions, social or sightseeing functions or works visits. The Congress headquarters is at the Dorchester Hotel, London, W.1. Afterwards, mainly for overseas visitors, there is a choice of two post-Congress tours (June 26 to July 2) —the first covering the Midlands and Lancashire, and the second Scotland, North East Coast and Sheffield. As usual, while members, guests, and overseas delegates are engaged in committee, technical discussions or works visits there are special functions arranged for their ladies. Again, as usual, the whole Congress is meticulously organized as to detail and only needs co-operation as to punctuality and timing on the part of those attending to make it run like clockwork. This is the first time since 1939 that an International Foundry Congress has been held in this country and there is no doubt it will be well supported.

Special Notes

Overseas delegates will have been issued with a registration card and on arrival in London, this card should be taken to the congress office where it will be exchanged for the programme, tickets, copies of papers, congress badge, etc.; British participants will have received these by post in advance.

Punctuality.—All the arrangements are worked to a very close schedule and any slight delay may completely dislocate the rest of the day's arrangements. Punctuality is therefore essential and delegates and ladies are requested to attend all functions at least *five minutes* before the advertised times.

Information Bureau.—For the convenience of delegates and ladies, an office will be open daily at the Congress headquarters, the Dorchester Hotel (Crush Hall, Ballroom Entrance) Park Lane, London, W.1, from June 19 to 24. If any information concerning the Congress is required, it may be obtained at the office where a competent staff of officials will be able to help. A representative of Thos. Cook & Son, Limited, will also be there to change travellers' cheques and to give any information required in connection with personal sightseeing, tours, etc. The Congress office is open for the following times:—Sunday, June 19: 10.00 a.m. to 3.00 p.m. Monday, June 20, Tuesday, June 21, and Wednesday, June 22: 9.00 a.m. to 5.00 p.m. Thursday, June 23, 9.00 a.m. to 12.30 p.m. and Friday, June 24, 9.00 a.m. to 4.30 p.m.

Correspondence.—Delegates who wish their correspondence forwarded to them during the period of the Congress should have it addressed:—c/o Institute of British Foundrymen, Dorchester Hotel, Park Lane, London, W.1.

PROGRAMME

Sunday, June 19:

10.00 a.m. to 3.00 p.m. Registration Office and Information Bureau will be open in the Crush Hall at the Dorchester Hotel, Park Lane, London, W.1. (Ballroom entrance).

2.15 p.m. Coaches leave Ballroom entrance of the Dorchester for a Garden Party by kind invitation of Mr. Barrington Hooper C.B.E., and Mrs. Hooper, at their home, Southward, Mount Park, Harrow.

On return, coaches will arrive at the Dorchester from 6.15 to 6.45 p.m. (Evening free).

Monday, June 20:

9.30 a.m. to 3.30 p.m. Committee and Council Meetings of the Institute of British Foundrymen at the Dorchester Hotel.

10.30 a.m. Sightseeing tour of the West End of London. Arrive at Dorchester Hotel on return at 12.30 p.m. (Delegates and ladies.) Delegates and ladies make their own arrangements for luncheon.

2.15 p.m. Visit to the Royal Mint; arrive Dorchester Hotel on return about 4.30 p.m.; (overseas delegates and their ladies only, limited to 24).

2.30 p.m. Sightseeing tour of the City of London. Arrive at Dorchester Hotel on return at 4.30 p.m. (Open to overseas delegates and *all* ladies.)

3.45 p.m. Annual general meeting of the Institute of British Foundrymen (members only), in the Ballroom at the Dorchester Hotel; evening free.

Tuesday, June 21:

9.30 a.m. Congress opens in the Ballroom of the Dorchester Hotel (all delegates and their ladies). Welcome to the overseas delegates by the president of the Institute of British Foundrymen. Official opening of the Congress by the Rt. Worshipful the Mayor of the City of Westminster.

Presentation of awards: (*a*) the Oliver Stubbs gold medal; (*b*) the E. J. Fox medal; (*c*) the Meritorious Services medal; (*d*) the British Foundry Medal and Prize, and (*e*) the John Bell Travelling Scholarship.

11.00 a.m. Presidential address by Dr. A. B. Everest.

11.30 a.m. The eighteenth Edward Williams Lecture "Metals Perfect and Imperfect," by Dr. T. E. Allibone, F.R.S.

12.45 p.m. for 1.00 p.m. Buffet luncheon at the Dorchester.

2.30 p.m. Two simultaneous technical sessions: (A) and (B) (see later). Papers 1119, 1120, 1121, and 1122.

5.00 p.m. to 5.30 p.m. Technical film displays.

6.00 p.m. to 7.30 p.m. Reception by Her Majesty's Government at Lancaster House, London, W.1. A member of the Government will receive the guests. (Informal dress.) (Note: The number of invitations to this Reception is of necessity restricted. Ladies will *not* attend this function.)

9.00 p.m. to 11.00 p.m. Reception by the president of the Institute and Mrs. Everest at the Hall of the Fishmongers' Company, London, E.C.4; (all delegates and ladies by invitation), (Note: Delegates attending

London, Piccadilly Area

the Government Reception are also invited to attend this function.) (Evening dress.)

Wednesday, June 22

9.00 a.m. Technical film displays at the Dorchester Hotel prior to the technical sessions.

9.30 a.m. to 5.00 p.m. Meeting of the International Committee on Testing Cast Iron in the Stanhope Room (committee members only).

9.30 a.m. Two simultaneous technical sessions (C) and (D), papers 1123, 1124, 1125, 1126, and 1127.

12.45 p.m. for 1.00 p.m. Luncheon in the Ballroom of the Dorchester Hotel (all delegates).

2.30 p.m. Two simultaneous technical sessions (E) and (F), papers 1128, 1129, 1130, 1131, and 1132.

5.00 p.m. to 5.30 p.m. Technical film displays will follow the technical sessions.

7.30 p.m. for 8.00 p.m. to midnight. "Piccadilly Fare"—informal dinner and cabaret in the Regina Suite at the Piccadilly Hotel, London, W.1. (Cocktail dress (dancing not included).)

Thursday, June 23

Coaches leave from the Ballroom entrance of the Dorchester Hotel for *one* only of the following works visits or group of works visits:—

9.00 a.m. (1) (*a*) Bagshawe & Company, Limited, Dunstable (morning), and (*b*) K. & L. Steelfounders & Engineers, Limited, Letchworth (afternoon). Luncheon and tea by kind invitation of the respective firms.

9.10 a.m. (2) (*a*) Langley Alloys, Limited, Slough, Bucks (morning) and (*b*) High Duty Alloys, Limited, Slough (afternoon). Luncheon and tea by kind invitation of the respective firms.

9.20 a.m. (3) (*a*) Morris Singer Company, Limited, London (morning), and (*b*) A.P. V.-Paramount, Limited, Crawley (afternoon). Luncheon at the Sugar Bowl Club, Burgh Heath, Tadworth; tea by kind invitation of A. P. V.-Paramount, Limited.

9.45 a.m. (4) (*a*) Hoover, Limited, Greenford (morning) and (*b*) British Non-Ferrous Metals Research Association, London (afternoon). Luncheon and tea by kind invitation of the respective organizations.

10.00 a.m. (5) (*a*) R. & A. Main, Limited, Edmonton (morning) and (*b*) Belling & Company, Limited, Enfield (afternoon). Luncheon and tea by kind invitation of the respective firms.

10.10 a.m. (6) Morgan Crucible Company, Limited, London (all-day visit). Luncheon and tea by kind invitation of the firm.

10.20 a.m. (7) Lake & Elliot, Limited, Braintree (all-day visit). Luncheon by kind invitation of the company.

10.30 a.m. (8) By river steamer or rail to Ford Motor Company, Limited, Dagenham.

For members of the International Committee and sub-committees there will be meetings occupying the whole day and in the evening (7.30 p.m. for 8.00 p.m.) dinner at the Dorchester Hotel (Orchid Suite) (official representatives—and their ladies—of the constituent associations on the Committee and members of Council—and their ladies—of the Institute of British Foundrymen only); (evening dress); (entrance Deanery Street.)

Evening free for other delegates.

Friday, June 24:

9.00 a.m. Technical film displays prior to the technical sessions.

9.30 a.m. Two simultaneous technical sessions. (G) and (H) papers Nos. 1133, 1134, 1135, 1136, and 1137.

12.45 p.m. for 1.00 p.m. Luncheon in the Ballroom of the Dorchester Hotel; (delegates and ladies); (Ballroom entrance).

2.30 p.m. Closing ceremony of the Congress at the Dorchester Hotel (Ballroom entrance). Presentation of the Award of the International Committee.

6.45 p.m. Reception by Dr. A. B. Everest (president) and Mrs. Everest prior to the Annual Banquet at the Dorchester Hotel; (Ballroom entrance).

7.30 p.m. to 1.00 a.m. Congress Banquet in the Ballroom of the Dorchester Hotel, Park Lane, W.1.; (evening dress). The Banquet will be followed by dancing until 1.00 a.m.

Saturday, June 25:

9.23 a.m. All-day excursion to Blenheim Palace and Oxford with conducted tour of the Palace and Oxford colleges. (Evening free.)

Ladies' Programme

(Where different from that given earlier)

Sunday, June 19 and Monday, June 20—as given above.

Tuesday, June 21:

9.30 a.m. Ladies are invited to attend the opening of the Congress in the Ballroom of the Dorchester Hotel.

10.45 a.m. Informal reception by Mrs. Everest at the Dorchester Hotel (Ballroom entrance); coffee by invitation.

12.45 p.m. Buffet luncheon.

Hampton Court Palace

Coaches leave the Ballroom entrance of the Dorchester Hotel for *one* only of the following visits:—

2.30 p.m. (1) Ackroydon Housing Estate (L.C.C.), Victoria Drive, Wandsworth.

2.35 p.m. (2) City Livery Halls.

2.40 p.m. (3) J. Lyons & Company, Limited, Cadby Hall, London (tea).

2.45 p.m. (4) Derry & Toms, Limited, Kensington High Street, London, W.8 (tea in the Rainbow Restaurant).

Wednesday, June 22

Coaches leave Ballroom entrance of Dorchester Hotel, Park Lane, London, W.1, for *one* only of the following visits:—

9.30 a.m. (5) Hever Castle, Hever, Kent (morning). Luncheon at the Elizabethan Barn, Tunbridge Wells. Lullingstone Castle (silk farm, gardens, Roman villa) (afternoon); tea at Lullingstone Castle.

9.35 a.m. (6) Penshurst Place, Tunbridge, Kent (gardens) (morning). Luncheon at the Elizabethan Barn, Tunbridge Wells. Lullingstone Castle (silk farm, gardens, Roman villa) (afternoon); tea at Lullingstone Castle.

9.40 a.m. (7) Knole House, Sevenoaks, Kent (morning). Luncheon at Bligh's Hotel, Sevenoaks. Drive through Kentish villages, including Chiddingstone (afternoon); tea at the Old Barn, Hildenborough.

Thursday, June 23

9.30 a.m. Coaches leave the Ballroom entrance of the Dorchester Hotel for the following visits:—

(8) Whitefriars Glass Works, Harrow (morning); luncheon at the Tuck Shop, Harrow; and Harrow School and gardens (afternoon); tea at the King's Head, Harrow-on-the-Hill.

or

11.00 a.m. (9) Excursion by river steamer from Charing Cross Pier (ladies make their own way to Charing Cross Pier) to Hampton Court; luncheon on the steamer; inspection of state apartments and gardens at Hampton Court during the afternoon. Tea at Nuthalls "Court" Restaurant and return by motor-coach.

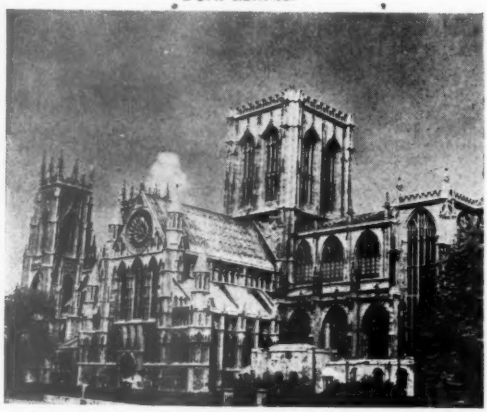
Evening free (except for those ladies attending the International Committee dinner).

Friday, June 24

Coaches leave Ballroom entrance of the Dorchester Hotel for *one* only of the following mannequin parades:—(10) Norman Hartnell; (11) Charles Creed; (12) Ronald Paterson; (13) Lachasse; (14) Worth.

10.30 a.m. (16) Visit to the leather works of Finnigans, Limited, London, W.1.

York Minster



London, Tower Bridge

Programme of Papers

(Note: During the first half-hour of morning sessions and the last half-hour of afternoon sessions, a series of interesting technical films will be shown.)

Tuesday, June 21

2.30 p.m. to 5.30 p.m. Two simultaneous sessions at the Dorchester Hotel, London, W.1.

SESSION A (Ballroom)

No. 1119: "Evaluation of Casting Processes," by Hiram Brown, B.S. (Exchange Paper from the American Foundrymen's Society.)

No. 1120: "Residual Stresses in Castings," by Prof. Albert Portevin and J. Pomey. (Exchange Paper from *l'Association Technique de Fonderie*).

SESSION B (Orchid Room)

No. 1121: "Influence of Grain-size on the Structure, Pressure-tightness and Tensile Properties of Sand-cast Bronzes and Gunmetals," by A. Cibula, M.A., A.I.M. (Paper from the British Non-Ferrous Metals Research Association.)

No. 1122: "Recent Aluminium Casting Developments," by L. Fletcher. (Report of the Light Metal Founders' Association submitted through the Aluminium Development Association.)

Wednesday, June 22

9.00 a.m. to 12.30 p.m. Two simultaneous sessions at the Dorchester Hotel, London, W.1:—

SESSION C (Holford Room)

No. 1123: "Metal and Mould Research on Steel Castings." Part I. "Solidification Mechanism," by J. A. Reynolds, B.SC., PH.D., and A. Preece, M.SC., F.I.M. Part II. "Mould- and Core-bonding Agents," by J. M. Middleton, A.MET., A.I.M., and J. White, D.SC., PH.D., F.I.M. (Paper from the British Steel Castings Research Association.)

No. 1124: "Quality Control in a Large Foundry," by Dott. Ing. Romolo Baggio. (Exchange Paper from the *Associazione Italiano di Metallurgia.*)

SESSION D (Orchid Room)

No. 1125: "Chemical Reactions in the Cupola," by

Edinburgh Castle

Professor Dr.-Ing. G. A. H. Jungbluth and K. Stockkamp. (Exchange Paper from *Verein Deutscher Giessereifachleute.*)

No. 1126: "Comparative Study of Melting Furnaces in Grey-iron Foundries," by Dr. Ing. B. Marincek. (Exchange Paper from the *Verband Schweizerischer Eisengiessereien.*)

No. 1127: "Results of Metallurgical Studies on the M.B.C. and ADS Cupolas," by Professor A. De Sy and R. Doat, Ing. Civ. Métall. A.I.Lg., Mr. R. Balon and Mr. L. Winandy. (Exchange Paper from *l'Association Technique de Fonderie de Belgique.*)

2.30 p.m. to 5.30 p.m. Two simultaneous sessions at the Dorchester Hotel, London, W.1:—

SESSION E (Orchid Room)

No. 1128: "Behaviour of Moulding Sands at High Temperatures," by W. B. Parkes and R. G. Godding. (Paper from the British Cast Iron Research Association.)

No. 1129: "Spalling of Green-sand Moulds and its Relation to Casting Defects," by H. Pettersson. (Exchange Paper from *Sveriges Mekanförbund.*)

No. 1130: "Effect of Mould Material on the Solidification Rate of Cast Metals." (Report of Sub-committee T.S. 46 of the Technical Council.)

SESSION F (Holford Room)

No. 1131: "Widmanstätten and other Abnormal Graphite Forms in Cast Iron," by E. Bull Simonsen, Mag. Scient, and Floyd Brown, D.SC. (Exchange Paper from the *Norges Stoperitekniske Forening.*)

No. 1132: "Nomogram for Fairly-hot Non-alloyed Iron Cast in Ordinary Dry Sand." by Svend Thegel. (Exchange Paper from the *Stoberiingeniorernes Klub.*)

Friday, June 24

9.00 a.m. to 12.30 p.m. Two simultaneous sessions at the Dorchester Hotel, London, W.1:—

SESSION G (Orchid Room)

No. 1133: "Moulding in an Indian Foundry," by S. G. Athanikar. (Exchange Paper from the Institute of Indian Foundrymen.)

No. 1134: "A Jobbing Investment Foundry in South Africa," by J. Steele. (Exchange Paper from the South African branch of the Institute.)

No. 1135: "Foundry Industry in Australia," by A. W. Silvester. (Exchange Paper from the Australian (Victoria) branch of the Institute.)

SESSION H (Holford Room)

No. 1136: "Ingates." (Report of Sub-committee T.S. 24 of the Technical Council.)

No. 1137: "Gases in Cast Iron," by H. Morrogh. (Report of the Joint Gases Committee of the Institute of British Foundrymen and the British Cast Iron Research Association.)

POST-CONGRESS TOURS

As recorded on the first page of this programme, there are two post-congress tours to be held during the week June 26 to July 2. Tour No. 1 to the Midlands and Lancashire, and Tour No. 2 to Scotland, the North East Coast and Sheffield. In each area, the local branch of the Institute is acting as host for a number of social functions and, of course, many of the firms themselves are providing hospitality. In all cases, too, complementary programmes for the ladies of the party have been arranged. It is assumed, of course, that the parties for the two tours will be chiefly made up of overseas delegates.

Tour No. 1

Sunday, June 26

11.10 a.m. Leave Paddington Station, London, for Leamington; luncheon on train; coach tour of Warwick and Shakespeare country (afternoon). Arrive Queen's Hotel, Birmingham, 6.00 p.m. approx.; dinner at hotel.

Monday, June 27

Coaches leave from Queen's Hotel for *one* only of the following works visits or groups of works visits:—

8.30 a.m. (1) Lloyds (Burton), Limited (morning) and F. H. Lloyd & Company's steel foundry at Wednesbury (afternoon); luncheon by kind invitation of the firm.

8.45 a.m. (2) (*a*) Sterling Metals, Limited, Nuneaton, and (*b*) British Piston Ring Company, Limited, Coventry (afternoon). Luncheon at the Leofric Hotel, Coventry. Tea by kind invitation of the latter firm.

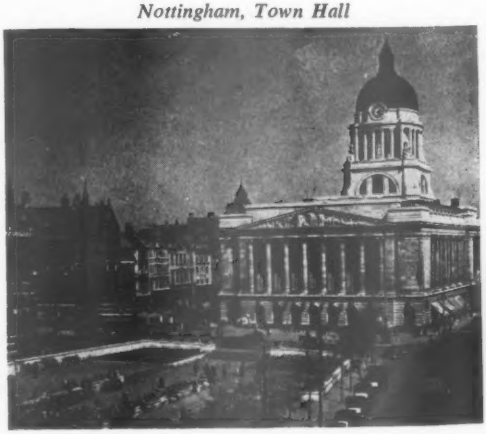
9.20 a.m. (3) Austin Motor Company, Limited, Longbridge (all-day visit), luncheon and tea by invitation of the company.

9.20 a.m. (4) (*a*) W. & T. Avery, Limited's, new Tame Bridge foundry (morning), and (*b*) William Mills, Limited, Wednesbury (afternoon). Luncheon by kind invitation of W. & T. Avery, Limited.

Ladies—morning free.

12.30 p.m. Luncheon for ladies at the Queen's Hotel, Birmingham. Coaches leave from the Queen's Hotel, Birmingham, for:—

Nottingham, Town Hall



1.40 p.m. ladies' visit to Cadbury Bros., Limited, Bournville. Tea by kind invitation of the firm.

7.00 p.m. to 7.40 p.m. Cocktail reception at the Queen's Hotel, Birmingham (by invitation of the Birmingham branch); (delegates and ladies).

8.00 p.m. to 11.00 p.m. Dinner at the Botanical Gardens, Birmingham; (delegates and ladies).

Tuesday, June 28:

Coaches leave from Queen's Hotel for *one* only of the following works visits:—

9.20 a.m. (5) Bradley & Foster, Limited, Darlaston. Luncheon by kind invitation of the company.

9.30 a.m. (6) Midland Electric Manufacturing Company, Limited, Birmingham. Luncheon by kind invitation of the company.

10.30 a.m. Ladies proceed from the Queen's Hotel on foot for guided tour of Marshall & Snelgrove's fashion store, New Street, Birmingham.

12.30 p.m. Luncheon for ladies at the Queen's Hotel, Birmingham.

2.38 p.m. Depart by train to Nottingham (delegates and ladies). (Tea on train).

6.30 p.m. to 8.00 p.m. Cocktail party at the Victoria Hotel, Nottingham (by kind invitation of the East Midlands branch of the Institute). Return to respective hotels by coach for dinner. Evening free.

Wednesday, June 29:

Delegates will proceed by coach on *one* only of the following visits:—

9.15 a.m. (7) Ley's Malleable Castings Company, Limited, Derby (morning). Qualcast, Limited, Derby (afternoon). Luncheon and tea by kind invitation of the firms.

9.15 a.m. (8) Stanton Ironworks Company, Limited, near Nottingham (all-day). Luncheon and tea by kind invitation of the firm.

10.00 a.m. Coaches leave from respective hotels for:—Ladies' visit to Hardwick Hall. Luncheon and tea *en route*.

5.30 p.m. Delegates and ladies depart by coach from hotels for station and join train to Manchester (dinner *en route*). Evening free.

Thursday, June 30:

Coaches will leave from hotels for:—

9.30 a.m. (9) Works visit to Metropolitan-Vickers Electrical Company, Limited (morning), and Joseph Berry, Limited, Swinton (afternoon). Luncheon by kind invitation of Metropolitan-Vickers Electrical Company, Limited.

George Square, Glasgow

London, Westminster Abbey

10.00 a.m. Coaches leave from respective hotels for ladies' visit to the Wedgwood Pottery Company, Stoke-on-Trent; luncheon *en route*. Return to Manchester at 5.0 p.m., delegates and ladies will dine at their own hotels.

6.45 p.m. Coaches leave from respective hotels for a theatre visit (delegates and ladies).

Friday, July 1:

Coaches leave from the respective hotels for:—

9.30 a.m. (10) Works visit to the National Gas & Oil Engine Company, Limited, Ashton-under-Lyne (morning) and Mather & Platt, Limited, Manchester (afternoon). Luncheon and tea by kind invitation of the respective firms.

10.00 a.m. Ladies' excursion by motor coach to Chester; luncheon in Chester; afternoon trip on the River Dee; tea in Chester; return to Manchester 6.00 p.m.

7.30 p.m. for 8.00 p.m. Informal dinner followed by entertainment; (delegates and ladies). (By kind invitation of the Lancashire branch.)

Saturday, July 2:

9.45 or 10.5 a.m. Depart Manchester by train for London (luncheon on train).

Tour No. 2

Sunday, June 26:

10.00 a.m. Leave Euston Station, London, for Glasgow. Luncheon, tea and dinner *en route*.

7.45 p.m. Arrive Central Hotel, Glasgow; evening free. (Note: delegates and ladies who prefer to do so may travel by air to Glasgow, leaving London at 5.45 p.m. and arriving Glasgow at 9.30 p.m.)

Monday, June 27:

Delegates leave by motor coach for *one* only of the following groups of works visits:—

9.00 a.m. (1) Glenfield & Kennedy, Limited Kilmar-

I.B.F. Post-congress Tours

nock (morning), and Renfrew Foundries, Limited (afternoon). Luncheon and tea by invitation of these firms.

9.00 a.m. (2) Glenfield & Kennedy, Limited (morning), and Babcock & Wilcox, Limited, Renfrew (afternoon). Luncheon and tea by invitation of the firms.

9.00 a.m. Ladies will leave for a motor-coach tour of the "Three Lochs." Return to Glasgow for luncheon at 1.00 p.m. at the Grosvenor Restaurant; afternoon free.

7.30 p.m. Dinner at the Grosvenor Restaurant; (delegates and ladies); (by invitation of the Scottish branch).

Tuesday, June 28:

9.00 a.m. (3) Coaches leave Central Hotel, Glasgow, for works visit to Wm. Beardmore & Company, Limited, Glasgow. Luncheon by kind invitation of the firm.

9.00 a.m. Ladies leave Central Hotel, Glasgow, for motor-coach excursion to Edinburgh; luncheon at North British Hotel, Edinburgh; afternoon free.

2.00 p.m. Delegates leave Glasgow for Edinburgh, and may join ladies in Edinburgh on arrival.

4.00 p.m. Tea at the North British Hotel, Edinburgh (delegates and ladies).

5.14 p.m. Leave Edinburgh by train for Newcastle-upon-Tyne (dinner on train); evening free.

Wednesday, June 29:

Coaches leave from the hotels, Newcastle-upon-Tyne for *one* only of the following works visits:—

9.40 a.m. (4) C. A. Parsons & Company, Limited, Heaton Works, Newcastle-upon-Tyne.

9.40 a.m. (5) Hawthorn Leslie (Engineers), Limited, Newcastle-upon-Tyne.

Ladies—morning free.

12.15 p.m. 12.30 p.m. Luncheon at the Royal Station Hotel, Newcastle-upon-Tyne; (delegates and ladies).

Coaches leave the Royal Station Hotel, for *one* only of the following works visits:—

1.40 p.m. (6) Jarrow Metal Industries, Limited.

1.40 p.m. (7) North Eastern Marine Engineering Company (1938), Limited. Tea by kind invitation of the companies.

1.45 p.m. Coaches leave Newcastle-on-Tyne for:—Ladies' motor-coach tour of Rothbury; visit to Cragside; tea *en route*.

6.00 p.m. Coaches leave from hotels for a visit to the Roman Wall at Chollerford and dinner at the Royal Hotel, Hexham-on-Tyne (dinner by invitation of the Newcastle branch); (delegates and ladies) return to hotels in Newcastle-upon-Tyne.

Thursday, June 30:

9.55 a.m. Depart Newcastle-upon-Tyne by train for Sheffield, luncheon on train.

2.00 p.m. (approx.) Coaches leave Grand Hotel, Sheffield, for:—

(8) Works visit to the Brightside Foundry & Engineering Co. Ltd., Sheffield. Ladies—afternoon free.

7.00 p.m. Coaches leave Grand Hotel, Sheffield, for reception and dinner at the Royal Victoria Hotel, Sheffield (by invitation of the Sheffield branch).

Friday, July 1:

Coaches leave from the Grand Hotel, Sheffield, for:—

9.00 a.m. (9) Visit to the works of English Steel Castings Corporation, Limited, Sheffield (morning) and Osborn Foundry & Engineering Company, Limited, Sheffield (afternoon). Luncheon and tea by kind invitation of these companies.

10.00 a.m. Coaches leave from the Grand Hotel, Sheffield, for:—

Ladies' motor-coach excursion to Haddon Hall; luncheon *en route*; tea at hotel.

4.50 p.m.—By train to London (dinner on train).

International Award

Mr. V. C. Faulkner (Hon. M.I.B.F. and Editor of the "Foundry Trade Journal") has been nominated this year to receive the Foundry Technical Association's Award of Honour at the International Foundry Congress in London. The award (about two feet high) which is shown in our illustration consists of an exact reproduction of the original "Perseus" of Benvenuto Cellini, which is in the National Museum in Florence. It is in bronze and was made by the lost-wax process, and by the same methods and in the same alloys as used by Benvenuto Cellini.

This award is held by the Institute of British Foundrymen, the hosts of this year's International Congress, for 12 months. Since the inauguration of the award, it has been held in turn by respective foundry associations in Belgium (1951), America, France and Italy. A replica of the main award shown on the right of the original is retained by Mr. Faulkner in perpetuity.

Congress Film Shows

At the Congress, to add general interest to the technical sessions, a comprehensive series of films will be shown. The times set aside for this purpose are from 5 to 5.30 p.m. on Tuesday, June 21, from 9 to 9.30 a.m. and from 5 to 5.30 p.m. on Wednesday and from 9 to 9.30 a.m. on Friday. The loan of the films and the arrangements for their showing at the Dorchester Hotel have been in the hands of Mr. Frank Hudson, F.I.M., who is to be congratulated on the variety of topics available. From the list of films given below, a suitable selection will be made for showing, according to the time available.

FILMS TO BE SELECTED FROM THE FOLLOWING FOR SHOWING AT THE INTERNATIONAL FOUNDRY CONGRESS IN LONDON

Steel Castings

No. 1, "Britain's Heaviest Steel Casting."
Source: English Steel Corporation, Limited, River Don Works, Sheffield (Dr. C. J. Dadswell).
Showing time: 20 to 25 min.
Description: 16 mm., sound (colour), illustrating moulding and pouring of large hydraulic-press crosshead-beam castings for U.S.A., having a finished weight of 185 tons.

No. 2, "Sand and Steel."
Source: Allegheny Ludlum Steel Corporation, 2020 Oliver Building, Pittsburg 22, Pa., U.S.A. (copy available in Great Britain from the Film Library, U.S. Operations Mission, 5, Grosvenor Square, London, W.1).
Showing time: 26 min.
Description: 16 mm., sound (colour), covers the production of stainless and heat-resisting steel castings from pattern making to final finishing operations and testing.

No. 3, "Melting and Refining of Stainless Steel."
Source: Allegheny Ludlum Steel Corporation, 2020 Oliver Building, Pittsburg 22, Pa., U.S.A. (copy available in Great Britain from Central Film Library, Government Buildings, Bromyard Avenue, Acton, London, W.3, under index No. V1184).
Showing time: 23 min.
Description: 16 mm., sound (colour), shows modern procedures and techniques in the melting and refining of stainless steel in a 50-ton electric-arc furnace, using oxygen injection.

No. 4, "Manufacture and Uses of Alloy-steel Castings."
Source: Brown-Firth Research Laboratories, Princess Street, Sheffield, 4 (Mr. S. H. Thorpe).
Showing time: 30 min.
Description: 16 mm., sound (colour), showing the manufacture and uses of alloy-steel castings at the Scunthorpe Works of Thos. Firth & John Brown, Limited.

Iron Castings

No. 5, "S.G. Iron—Cast Iron that Bends."
Source: Mond Nickel Company, Limited, Thames House, Millbank, London, S.W.1.
Showing time: 15 min.
Description: 16 mm., sound (colour), survey of the properties and engineering applications of this new type of cast iron.

Non-ferrous Castings

No. 6, "New Methods for Old."
Source: Mond Nickel Company, Limited.
Showing time: 20 to 25 min.
Description: 16 mm., sound (colour). This film records developments arising from the Brassfoundry Productivity Team's Report and is aimed at improvement in quality and increase in output from the smaller brassfoundry. The equipment and processes demonstrated include the installation of an impeller rammer; a simple layout in which all items of equipment are portable; modern lift-out crucible furnaces and control of melt quality; the use of exothermic and heat-insulating sleeves to reduce the size of feeders; the use of a core-blower and high-speed abrasive cutting-off wheels.

No. 7, "Semi-continuous Casting of Bronze."
Source: Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex (Mr. W. R. Lewis).
Showing time: 8 min.
Description: 16 mm., sound (colour). This film shows the make-up and melting of the furnace charge, the assembling of the tundish upon the graphite die, the casting of the bronze into the tundish, and the emergence of the cast rod from the graphite die. The modified die for making hollow rods is also shown.

No. 8, "Metal without an Equal."
Source: Ampco Metal, Inc., 1745 South 28th Street, Milwaukee, 46, Wis. U.S.A.
Showing time: 20 min.
Description: 16 mm., sound (colour); this film is a technical presentation of aluminium-bronze alloy production in the Ampco plant. Operations such as patternmaking, coremaking, pouring, and extrusion are shown. The final sequences deal with the application of aluminium-bronzes in industry.

General Interest

No. 9, "The ADM of Cores."
Source: Archer-Daniels-Midland Company, 2191 W. 110th St., Cleveland, 2, Ohio, U.S.A.
Showing time: 25 min
Description: 16 mm., sound (colour); deals with the theoretical and practical aspects of coremaking and demonstrates methods for establishing better control in the coreshop based upon core production at the Studebaker foundry in the U.S.A. (Note :—Shown at International Congress held in Florence, 1954, and recommended by Mr. E. M. Currie of the International Meehanite Metal Company Limited.)

No. 10, "Aluminium-alloy Matchplates."
Source: Mond Nickel Company, Limited.
Showing time: 10 to 15 min.
Description: 16 mm., sound (colour), illustrates the methods employed in the production of pressure-cast aluminium-alloy matchplates in plaster moulds, so widely used in the U.S.A.

No. 11, "Flow of Metal into Moulds."
Source: Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3.
Showing time: 25 to 30 min.
Description: 16 mm., sound (colour); revised version of film made by sub-committee T.S. 35 showing how the flow of metal into moulds is affected by different types of ingates, etc.

No. 12, "Shell-Moulding."
Source: Monsanto Chemical Company, Plastics Division, Dept. SM, Springfield 2, Mass. U.S.A.
Showing time: 18 min.
Description: 16 mm., sound (black and white). This film traces the development of resin shell-binders and describes techniques of shell-production methods from crude manual operations to those involving huge multi-station machines.

No. 13, "Shell-Moulding."
Source: Cooper Alloy Foundry Company, Bloy and Ramsay Avenues, Hillside 5, N.J. U.S.A.
Showing time: None stated.
Description: 16 mm. sound (black and white); produced by the National Association of Manufacturers for use on "Industry on Parade" television programme. The film provides an excellent introduction for discussion of shell-moulding techniques.

No. 14, "Outstanding Opportunities for the Foundry Industry."
Source: Central Foundry Division, General Motors Corporation, Saginaw, Mich. U.S.A. (Mr. J. H. Smith, general manager).
Showing time: 7 min.
Description: 16 mm., sound (colour); shows methods for increasing productivity in the foundry and illustrates shell-moulding methods employed by General Motors Corp.

No. 15, "Operation CO_2."
Source: Foundry Services Limited, Long Acre, Nechells, Birmingham.
Showing time: 20 min.
Description: 16 mm., sound (black & white); demonstrates the use of the CO_2-gas process for producing moulds and cores for iron castings up to 3 tons in weight.

No. 16, "Mechanization in Coremaking."
Source: British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10.
Showing time: 40 min.
Description: 16 mm., sound (black and white); showing mechanization in coreshops in American foundries; sponsored by Beardsley and Piper Company, 2541 North Keeler Avenue, Chicago, Ill. U.S.A.

No. 17, "Furnace Control."
Source: British Iron and Steel Federation, Film Library, 269, Kingston Road, London, S.W.19.
Showing time: 15 min.
Description: 16 mm., sound (black and white); illustrates the various instruments required to efficiently control the operation of open-hearth steel-melting furnaces.

Congress Organization

Triumph of Integrated Committee work

It is difficult to realize that for over a year committees have been at work to plan for the success of the Congress and its associated study tours. Early in the discussions there were disappointments in that programmes from the branches of the Institute located in Bristol and West of England, South Wales and Middlesbrough could not be keyed into the programme of visits. Once however, the skeleton of the two post-congress tours was established there was little difficulty in giving them substance, and a real debt of gratitude is due to the district committees for reconciling diverse requirements of their neighbouring territories.

In London it took fewer than six committee meetings to establish the programme, which means that a few individuals had to be delegated to arrange considerable details. Very important work was undertaken by the Ladies' Committee. Yet when every item had been thrashed out, it still remained for Mr. Lambert and his staff at the Manchester head office of the Institute to arrange all the details. Though many people have contributed in large measure to the creation of the programme, special mention should be made of Mrs. Everest and Mrs. Faulkner, Mr. Mochrie, Mr. Barrington Hooper, Mr. Glenny and Mr. F. A. Wilson. The committees have been presided over by Dr. Everest and Mr. John Bell whose advice has been invaluable.

The membership of the various committees is given below and so that they may be accorded due recognition during the Congress (where, doubtless, they will be continuing their good work) their portraits are printed on the succeeding pages.

Permanent Congress Committee

London Section

DR. A. B. EVEREST (Chairman)	Mond Nickel Company Limited, Thames House, Millbank, London, S.W.1.
V. DELPORT	Penton Publishing Company Limited, 2, Caxton Street, Westminster, London, S.W.1
V. C. FAULKNER	Foundry Trade Journal, John Adam House, Adelphi, London, W.C.2.
M. J. GLENNY	Dover Engineering Company Limited, 68, Victoria Street, Westminster, London, S.W.1
BARRINGTON HOOPER, C.B.E.	Foundry Trade Journal, John Adam House, Adelphi, London, W.C.2.
F. HUDSON	Mond Nickel Company Limited, Thames House, Millbank, London, S.W.1.
F. ARNOLD WILSON	William Jacks & Company Limited, Winchester House, Old Broad Street, London, E.C.2.
W. WILSON	Welwyn Foundry Company Limited, Welwyn Garden City, Herts.
W. G. MOCHRIE	Tyseley Metal Works Limited, Balfour House, Finsbury Pavement, London, E.C.2
G. LAMBERT (National Secretary)	Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester
N. P. NEWMAN (ex-officio) (Conference Treasurer)	Newman, Hender & Company Limited, Woodchester, Glos.

Representatives of Branches

A. KIRKHAM (Lancashire)	Sir W. H. Bailey & Company Limited, Albion Works, Patricroft, Lancs.
E. R. DUNNING (Birmingham)	55, Shakespeare Drive, Shirley, Warwickshire.
A. MARSHALL (Scottish)	60, St. Enoch Square, Glasgow, C.1.
J. H. PEARCE (Sheffield)	31, Causeway Head Road, Dore, Sheffield.
C. STEWART (Newcastle)	22, Readhead Road, South Shields.
P. A. RUSSELL (East Midlands)	S. Russell & Sons Limited, Bonchurch Street, Leicester.
F. SHEPHERD, J.P. (Tees-side)	Head, Wrightson & Company Limited, Teesdale Iron Works, Thornaby-on-Tees
A. S. WALL (Wales and Monmouth)	14, Palace Avenue, Llandaff, Cardiff.

Ladies' Committee

MRS. A. B. EVEREST (Chairman)

MRS. V. C. FAULKNER

MRS. V. DELPORT

MRS. F. HUDSON

MRS. F. A. WILSON

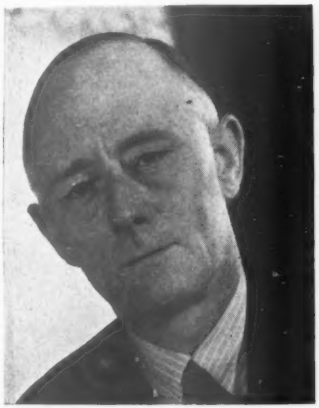
MRS. W. G. MOCHRIE

MRS. M. GLENNY

W. G. MOCHRIE

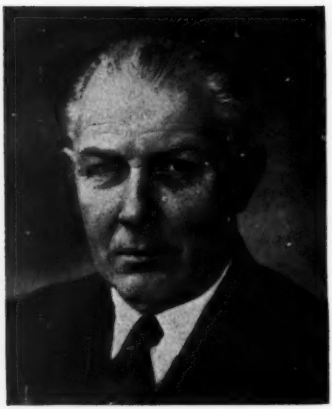
V. C. FAULKNER

G. LAMBERT



F. HUDSON

F. ARNOLD WILSON



M. J. GLENNY

N. P. NEWMAN

W. WILSON

V. DELPORT

The London Committee, under the able chairmanship of Dr. A. B. Everest, has been responsible for the Congress arrangements in London, and their photographs are printed on the preceding page. Representatives of the Branches of the Institute on the Congress Committee who, together with the London Committee, have organized the Post-Congress Tours and have been responsible for the social events in their respective areas, are shown below.

F. SHEPHERD, J.P.

E. R. DUNNING

A. KIRKHAM

P. A. RUSSELL

J. H. PEARCE

C. STEWART

A. S. WALL

A. MARSHALL

MRS. A. B. EVEREST

Ladies' Committee

The Ladies' Committee, headed by Mrs. A. B. Everest, has been solely responsible for the programme of social functions arranged for the delegates' ladies. These include sightseeing tours of London, visits to the English countryside, mannequin parades, a visit to a fashion store, a chocolate factory, a trip by river steamer to Hampton Court and a leather factory. For such a varied and interesting programme the Ladies' Committee are to be congratulated. In addition to this valuable work the Ladies have also taken a share in the arrangements for all the other social events, along with their menfolk.

MRS. M. J. GLENNY

MRS. W. G. MOCHRIE

MRS. V. C. FAULKNER

MRS. F. HUDSON

MRS. F. ARNOLD WILSON

MRS. V. DELPORT

International Committee President

Yngve Ragnvald Wilhelm Granström, who is President of the International Committee of Foundry Technical Associations, was born in 1898 and graduated at the Royal Institute of Technology in Sweden in 1925. After two years as assistant editor of *Jernkontorets Annaler* he served for two years as a moulder at Svenska Maskinverken, Södertälje, AB Separator, Tullinge and Allmänna Svenska Elektriska Aktiebolaget (ASEA) Västeräs. In 1928 ASEA appointed him manager of the malleable foundry and in 1932 he was promoted to the post of manager of all this Company's foundries. From 1941-42 he served as technical manager at Norrahammars Bruk, and in the latter year was appointed technical and assistant managing director of AB W Dan Bergman Södertälje. In 1945 he became general manager of the foundries of ASEA at Västeräs, a post which he continues to fill. From 1939 to 1948 Mr. Granström was secretary of the Institute of Swedish Foundrymen and president of that Organization's Committees of research on cast iron and of foundry production.

In 1948 Mr. Granström became vice-president and from 1951-53 president of the foundry section of the Federation of Swedish Mechanical Engineering Industries, while in 1954 he was vice-president of the International Committee of Foundry Technical Associations. In addition Mr. Granström during 1954 was president of the foundry committee of the Swedish Metal Trades Employers Association. Amongst the many study trips which Mr. Granström has made abroad are visits to America in 1927-28 (scholarship of the Royal Swedish Academy of Science). He visited the USA again in 1952, and has made many trips to Germany, Italy, Czechoslovakia, France, and this country.

Edward Williams Lecture

The presentation of the Edward Williams Lecture by an eminent scientist is a feature of each annual conference of the Institute of British Foundrymen. At this year's International Congress, the lecture is to be given on Tuesday morning (June 21) by Dr. T. E. Allibone, Ph.D., F.R.S., who has chosen for his subject: "Metals, Perfect and Imperfect."

Dr. Allibone graduated in physics in the University of Sheffield in 1924 and obtained his Ph.D. in 1926 for research in metallurgy. He spent the next four years in the Cavendish Laboratory, Cambridge, working under Lord Rutherford on the acceleration of electrons by direct methods. For this work he was awarded an 1851 Senior Exhibition. In 1930 Dr. Allibone was appointed to take charge of the high-voltage laboratory of the Metropolitan-Vickers Electrical Company, Limited, Manchester. He was awarded the Röntgen Medal in 1935 and received four awards from the Institution of Electrical Engineers. During the early part of the war Dr. Allibone directed a team working on radar problems. In 1944 he went to America on the atomic-bomb project, and while in the States was in charge of a group of British and American scientific workers at the University of California under Professor E. O. Lawrence. Dr. Allibone has directed the laboratory of Associated Electrical Industries, Limited, at Aldermaston, Berkshire, from its inception in 1946. This laboratory is concerned with long-term research problems of a physical, chemical and metallurgical character. In 1953 he was also made a director of research for the Edison Swan Electric Company (a subsidiary of A.E.I.). He is a member of the Council of the British Electrical and Allied Industries Research Association and of the Council of the British Non-Ferrous Metals Research Association.

The annual Edward Williams Lecture was inaugurated as part of the annual proceedings of the Institute mainly as a result of the initiative of Dr. J. E. Hurst. It commemorates the year of office of Mr. C. Edward Williams, a very popular president. The objective was to invite each year a man of national or international reputation as a scientist or in any other kindred sphere to lecture on a subject and a plane somewhat removed from humdrum foundry practice. It was sought thereby to open the vista of members to the wider viewpoint of foundrywork in its relation to civilization generally. That this objective has been well fulfilled is shown by an imposing list of lecturers and lectures. The first was given in 1935 by Sir William Larke, K.B.E., who spoke on "Man and Metal," and they have continued yearly, with the exceptions of 1938, 1940 and 1941.

IBF National Works Visits Day

The sixth annual National Works Visits Day of the Institute of British Foundrymen will be held in the Bristol area on Friday, October 7. These visits days, which have been a conspicuously successful development of the Institute's activities, are particularly intended for those members who cannot spare the time to attend annual conferences but wish to take part in a national gathering of shorter duration.

Institute's Technical Council

Most of the papers and lectures given to the Institute of British Foundrymen represent the experience and opinions of the Author and the firm with which he is associated, but at an early date in the Institute's history it was realized that this was not enough. New knowledge would have to be sought, developments would have to be initiated, and in 1918 there was expressed a plea for the formation of a research organization. The British Cast Iron Research Association was the result, on the cast-iron side. From the outset it was entirely separate from the Institute of British Foundrymen, but the work involved in its establishment was largely carried out by some of the Institute's members. Close relations continue to exist between the Association and the Institute by mutual representation on the Councils of the two bodies and on some of the committees.

Further Developments

The growing activities of the Institute revealed, however, that there was still much work of a development character which could be carried out by members with facilities for experiment and observation under actual foundry conditions. For instance, increasing interest was being taken in cast-iron test- Association (as the British Standards Institution was formed under the chairmanship of Mr. John Shaw, a foundryman of vast experience and unbounded enthusiasm. The committee worked in collaboration with the B.C.I.R.A., and with similar committees in other countries and the results were placed at the disposal of the British Engineering Standards Association (as the British Standards Institution was then called) and eventually the well-known specification for cast iron, No. 321/28, was issued. Further technical work of this nature was put into action by the Technical Committee of the Institute which was formed in 1931 by Mr. William Jolley as its convener. The Committee decided policy and its work was carried out by sub-committees, one of which represented each branch of the industry.

In 1932, the sub-committee on malleable cast iron, under its convener Mr. J. W. Gardom, produced the Technical Committee's first technical report which was presented at Newcastle-upon-Tyne. Later, Mr. Gardom succeeded Mr. Jolley as convener of the Technical Committee and a number of reports were issued by the various sub-committees during the next 15 years.

Present Set-up

In 1946, the Technical Committee was completely reorganized and became the Technical Council, and separate sub-committees were set up to investigate subjects on which a need for research was expressed by the membership of the Institute, under specific terms of reference. This work has been continued in increasing volume since then and no fewer than 50 subcommittees to study subjects as wide apart as filming flow of metal and evaluation of soundness of cast iron have been formed and most of them have reported in detail on their conclusions at various meetings of the Institute; the findings are permanently recorded in the Institute's " Proceedings."

at the International Congress are that of sub-committees of the Institute which are to be presented at the International Congress are that of sub-committee T.S.24 on " Ingates " and a consolidated report of sub-committees T.S.21, 33, and 46 on " Effect of Mould Material on the Solidification Rate of Cast Metals "; extensive synopses of these reports are printed on pages 93 and 86. There is a third report included in the Congress programme— " Gases in Cast Iron," which is that of a joint committee of the British Cast Iron Research Association and the Institute, compiled by the committee Chairman, Mr. H. Morrogh. The synopsis for this is printed on page 94.

The work of the sub-committees of the Institute is continuing in expanding degree. Currently, research is proceeding on 17 projects as detailed in the following appendix. A comparatively new departure is that arrangements have been made to bring university research teams into the co-operative organization of sub-committee work and this has greatly strengthened the potential of the Technical Council for independent practical work with closely controlled variables, on selected projects. Normally, the Technical Council, which consists of elected representatives from each of the branches of the Institute, together with certain co-opted members from research and kindred institutions and institutes, meets about four times a year to receive progress reports from the sub-committee chairmen, and to consider new work. Each year, a full report on the work is issued to members by the chairman of the Technical Council. The present chairman is Mr. A. E. Peace and the vice-chairman Mr. J. McPheat.

Appendix

Current Work in Progress of IBF. Technical Sub-committees.

T.S. No.	Short title.	Chairman.
24	Ingates	F. J. McCulloch
32	Internal Stress	M. M. Hallett, M.Sc.
35	Flow of Metal	E. M. Currie, F.I.M.
37	Cast Iron Tests and Specifications	J. E. O. Little
38	Copper-base Alloy Castings	F. C. Evans, F.I.M.
39	Mould Drying	W. J. Colton
40	Atlas of Typical Non-ferrous Microstructures	A. Logan, F.I.M.
41	Atlas of Typical Steel Microstructures	C. H. Kain, A.M.I.Mech.E.
42	Atlas of Typical Cast Iron Microstructures	Dr. Brynmor Jones
43	Cupola Development	E. S. Renshaw, F.I.M.
44	Receivers	S. J. Sargood
45	Non-ferrous Quality Test	A. Logan, F.I.M.
46	Mould Materials	J. Hird
47	Foundry Coke	D. Fleming
48	Non-ferrous Surface Finish	R. W. Ruddle, M.A.
49	Feeding of Castings	H. G. Hall, F.I.M.
50	Design of Castings	J. Blakiston

(A sub-committee is also in course of formation on certain aspects of shell moulding.)

President's 20,000 Miles

In the course of his duties the president of the Institute of British Foundrymen, Mr. John Bell, at the completion of his term of office, will have travelled about 20,000 miles—over three-quarters of the distance round the world. Much of this impressive travel record has been incurred in attending branch annual social gatherings, and it speaks highly indeed of Mr. Bell's sense of duty that, though placed geographically at a disadvantage by his residence in Scotland, he has fulfilled every presidential engagement to date and it is certain will only fail to meet his few remaining commitments if an emergency arises.

Mr. Bell's first duty following his election at the Annual Conference at Glasgow in June was a meeting of the Technical Council on July 8 at Leeds. Following that he had the melancholy task of attending the funeral of Mrs. D. H. Wood at Birmingham in August and in the same month he was present at a meeting of the education committee in London. He was again present at a meeting of the Technical Council at Manchester in September prior to his participation in the International Foundry Congress at Florence from September 16 to October 2, where he was the Institute's principal representative charged with the duty of putting forward the Institute's views at the meeting of the International Committee of Foundry Technical Associations.

With the commencement of the winter session, Mr. Bell delivered an address at the meeting of the North East Scottish section at Arbroath on October 5, and three days later he was present at the National Works Visits Day in the Tees-side area. On October 15-16 Mr. Bell presided at the Council and committee meetings at Birmingham, while five days later he again attended a meeting of the North East Scottish section at Dundee.

The beginning of November was crowded with a number of engagements in London, including the London branch dinner. He returned to the Tees-side area on December 3 for the branch social and dance and delivered a short address to the assembled company. The next engagement, apart from a meeting of the Technical Council in London on December 15, was the dinner and dance of the Scottish branch, held—no doubt to his great relief—at Glasgow. His last duty in 1954 was to attend the Worshipful Company of Founders' dinner in London on December 23.

New Year Engagements

January was indeed a busy month! The president addressed a meeting of the Newcastle-upon-Tyne branch; visited the National Foundry Craft Training Centre at West Bromwich and on the evening of the same day proceeded to Derby to preside at the meeting of the executive committee, with meetings of the Council and other standing committees on the following day. At the annual dinner of the Birmingham branch on January 21, the president responded to the toast of "The Guests" and three days later joined in the Sheffield branch dinner. He completed an exacting month with the Lancashire branch dinner.

Two journeys over the border were made in February: first, on February 17, to the annual dinner of the Foundry Coke Merchants' Association in London. The next day he presided over the past-presidents' committee at Derby, and on February 26 he was present at the annual dinner and entertainment of the Bristol and West of England branch at Bristol.

A Presentation

At its meeting on March 9 at Manchester the Technical Council expressed appreciation to Mr. Bell, who was present, for the sustained interest he had shown in its work throughout his term of office. A short time later—on March 18—he attended the jubilee dinner of Lane & Girvan, Limited, where he was presented with a special gift of a green-sand casting in the form of a bronzed plaque of the "Last Supper" after Leonardo da Vinci's mural in the chapel of Santa Maria della Grazia in Milan.

The end of March and April was another period of crowded engagements. On March 30 Mr. Bell dined with members of Council of the West Riding of Yorkshire branch and addressed a general meeting of the branch. Next, he was at Ashorne Hill for the Foremen's Training Course; April 15 and 16 were spent at York for the meetings of the Council and standing committees; on the 23rd, he attended the annual dinner of the Wales and Monmouth branch; four days later he was present at the annual dinner of the Iron and Steel Institute and on the following day at the annual dinner of the Refractories Association, both in London. The month closed with his attendance at the annual dinner of the Lincolnshire branch at Grimsby. On May 6 he responded to the toast of "The Guests" at the meeting and dinner in London of the newly-formed Master Patternmakers' Association, and attended the dinner of the Silica and Moulding Sands Association in London on May 11, following with the annual dinner of the East Midlands branch at Leicester on May 13.

Closing Period

Such a memorable year of activity, perhaps surpassing that of any other president, will close for Mr. Bell when he hands over to Dr. A. B. Everest, the new president, on Monday, June 20, during the proceedings of the International Congress. There is no doubt that Mr. Bell will join the illustrious ranks of the Institute's past-presidents carrying with him the heartfelt gratitude of all members and officials of the Institute. These will be his due for the long and arduous services rendered—first as secretary for over 30 years of the Scottish branch and now for this marathon of duties as president. He will long be remembered, too, for the unfailing courtesy, quiet charm, dignity and elegant turn of phrase with which he has brought lustre to the Institute's escutcheon on so many informal as well as public occasions.

Forty foundries in the United Kingdom will be hosts to parties of delegates attending the International Foundry Congress. During the first week, there are visits to foundries in the London area. The following week alternative tours are offered, one to the Midlands and Lancashire and the other to Scotland, N.E. Coast and Sheffield. Short accounts of each establishment being visited are given in the following pages. In each area, the local branches of the Institute are to be hosts at social functions and parallel excursions are arranged for the ladies.

Ford Motor Company Limited

The party of delegates from the International Foundry Congress who visit the works of Ford Motor Company Limited on the banks of the Thames at Dagenham, Essex, will be able to study flow-production and techniques at one of the most mechanized plants in the country.

Further, it is expected that when they make their visit much of the piling for the site of the Company's new foundry will be well advanced. This work is part of Ford's huge £65-million expansion scheme and, if all the piles needed to support the new foundry building were laid end to end, they would stretch from Tower Bridge to Tilbury, or a distance of 20 miles.

Returning to the existing foundry, in which 3,000 men are employed, castings are produced in grey cast-iron, malleable iron, low-carbon alloys for cast chrankshafts, and alloy irons.

Between 500- and 600-tons of metal are melted each day in the melting plant. Melting operations are conducted in cupolas and electric furnaces, the installations include a hot-blast water-cooled cupola using a recuperative system, basic-lined cupolas, and cupola/electric furnace duplex units. Malleable iron is melted in a duplex unit and electrically annealed on a 16-hour cycle.

Moulding operations are carried out on five mechanized moulding systems using Sandslingers, jolt-squeeze and roll-over machines.

Core-blowing methods have been widely adopted in core-making operations, and a point of interest is that these include the latest Sutter-type machines made in England to U.S. specification.

An idea of the large production of the foundry can be gained from the fact that the coreshop produces up to 100,000 cores a day, requiring some 200-tons of sand. An idea of the variety of cores manufactured can be gained from the fact that, in the Ford Zephyr for example, 70 different shaped cores are required.

Coreshop equipment includes 14 vertical core ovens, 15 sand mixers, 1,500 coreboxes, 900 jigs and gauges, and over 90,000 core driers. Cleaning room equipment includes the latest type continuous shot-blast installation.

Application of new moulding techniques (see Fig. 1) will be found in the speciality department, where 5,500 rocker-arm castings per day are made by the " compaction " moulding of resin-bonded sand.

FIG. 1.—*Stages in the compaction-moulding process showing the 20-tier mould cut away to illustrate the running method, an example of the previous method (centre) and on either side the individual moulded sections. (Ford Motor Company, Limited.)*

When visitors are shown round Ford's, the foundry is high up on their itinerary. First they see the 1,800-ft. wharf, the longest privately-owned one of the Thames, where the basic raw materials are unloaded from ships at one end while new vehicles are loaded on to vessels at the other, destined for markets throughout the world (see illustration at the head of this article).

Blast Furnace

Iron ore, coal and limestone are unloaded at the rate of 600-tons an hour by tall mechanical unloaders, and electric transfer-cars take this material to the ore yard, which feeds the Ford blast furnace. The only blast furnace in Southern England, it holds a record for the greatest amount of iron produced in one lining.

This furnace smelts up to 600-tons of iron a day and is tapped every four hours, when the molten metal is poured into 65-ton rail-mounted ladles and subsequently cast in a pig-casting machine.

Nearby is the new battery of 48 coke ovens, which started operating in 1952. These can carbonize 900-tons of coal every 24-hours, giving 650-tons of coke and about 10,000,000 cub. ft. of gas, as well as valuable by-products such as tar, benzole and ammonium sulphate.

Perhaps the most striking feature of the factory when seen from the river is the gigantic power station, from the roof of which there is a magnificent view across Essex, and away on the other side to the Kentish hills. The power station is capable of supplying the domestic needs of 300,000 people, and does in fact supply electricity over and above the factory's needs to the national grid system.

The introduction of automatic machinery has revolutionized the machine shops. At the press of a button a transfermatic drilling and tapping machine can drill, tap and counter-sink simultaneously all holes in the front and rear of a cylinder block, with a capacity of 60 blocks an hour.

Assembly Lines

Perhaps what most fascinates the majority of visitors is to watch the vehicles taking shape on the final assembly lines. When the Consul and Zephyr models were introduced, a new line was constructed and the re-arrangement of the factory lay-out included the moving of 4,000 machine tools.

Other lines deal with the latest models—the new Prefect, the new Anglia, the Popular and the 5-cwt. van—as well as light commercials, heavy commercials, and new Fordson Major tractors.

Behind all these complex operations is the Ford principle of "flow" production, so that the right component is in the right place at the right time. Twelve miles of overhead monorail conveyor from the foundry onwards make this possible, together with hand-operated hoists and roller conveyors.

The first Ford car arrived in England just over 50 years ago. When Ford's moved from Manchester to Dagenham in 1930 the year's output was 4,574 vehicles—equal to three days' production now.

High Duty Alloys, Limited

High Duty Alloys, Limited, was founded, in 1928, for the purpose of developing and extending the use of aluminium and its alloys as forgings for both the aircraft and general engineering industries. At that time, the accommodation consisted of one bay in which was situated the general offices, laboratory, machine shop, a chill foundry with two 500-lb. and

FIG. 2.—*One of the Pneulec moulding machines at High Duty Alloys. It takes a box 72 by 54 by 24 in. deep and is shown partly rolled over.*

one 150-lb. capacity Morgan crucible furnaces, and a stamp shop which had three hammers and two salt baths. The first component produced was a piston for use in the Armstrong Siddeley "Jaguar" aero-engine, and was manufactured in "Y" alloy. This small beginning was rapidly supplemented by an increasing demand from other aero-engine manufacturers for forgings of various types. It was not until 1930, however, that interest in the casting process was stimulated and a small sand foundry was laid out. Shortly after the inauguration of this foundry, High Duty Alloys were appointed the sole licensees for the Rolls-Royce series of R.R. aluminium alloys. Nowadays, the casting division and the research and development division are situated at Slough, the rolling division at Briton Ferry, the forging division at Redditch, and the extrusion division at Distington. So, from the small bay occupied in 1928 there has grown an organization requiring over 80 acres for its various manufacturing processes, which cover almost every phase of light-alloy production.

Casting Division (Slough)

The casting division at Slough which, with the research and development section, will be seen by the Congress visitors, occupies 13 acres and is interested solely in the production of aluminium and magnesium-alloy castings. There are two sand foundries covering a combined floor space of approximately 46,000 sq. ft., and having facilities for manufacturing castings from a few ounces to 3,000-lb. Mechanized equipment has been installed wherever practicable and this includes 25

FIG. 3.—*View of part of the pressure-die-casting foundry at High Duty Alloys, Limited.*

FIG. 4.—*Bogie and moulding box in position preparatory to filling by impeller rammer. (High Duty Alloys.)*

moulding machines of various types and sizes. The largest roll-over machines (Fig. 2) operate with moulding boxes 72 by 54 by 24 in. and are provided with Sandslingers which eliminate a great deal of hand-ramming. All the moulding stations are supplied with sand from centralized processing-

plants by means of conveyors and hoppers. The melting equipment includes 1,000-lb. capacity oil-fired tilting crucible furnaces to supply the heavier moulding sections, and 350-lb. capacity Morgan bale-out furnaces in the smaller machine-moulding sections. Magnesium alloys are generally melted in steel lift-out crucibles ranging from 100- to 300-lb. capacity.

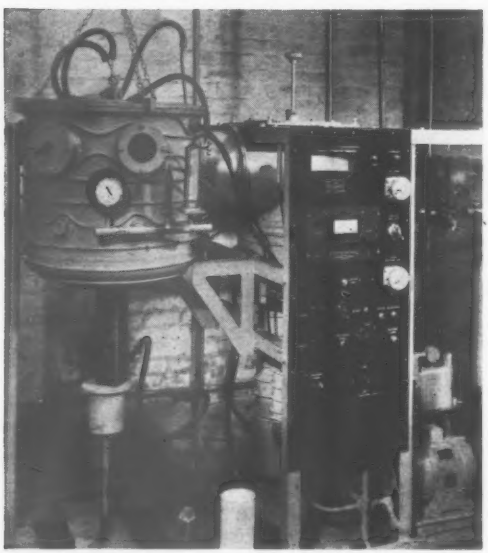
Coreshop

The supply of cores is maintained to both sand foundries and also the gravity-die foundry, and the coreshop is well equipped with mechanized plant including a sand drier, mixers, roll-over core-making machines, blowing machines and baking ovens. A particular feature is the production of moulds for air-cooled cylinder-head castings with deep and fine-pitched fins, also other intricate cores or moulds with the aid of an impeller rammer (Fig. 4). Vertical, continuous and batch-type ovens are installed for baking cores of all sizes

Gravity Die-casting Foundry

In the gravity-die-casting foundry, metal is prepared for casting in semi-rotary bulk-melting furnaces and these in turn serve batteries of Morgan bale-out furnaces. The metal is transferred from these by means of electrically-operated cranes and tilting ladles. Particular attention has been given to furnace control both from the point of view of pyrometrical equipment for temperature recording, and gauges which enable efficient control of furnace

FIG. 5.—*Furnace constructed in the British Non-ferrous Metals Research Association's workshops for melting and casting in vacuum on a laboratory scale.*



firing. The fettling shops are adjacent to the die-casting foundry to facilitate the easy flow of castings from die to the final inspection.

Pressure-die-casting Foundry

The demand for pressure-die-castings is constantly increasing, due to the fact that they can be produced to extremely fine tolerances and a smooth surface-finish, reducing final machining-operations and costs. The weight of castings produced varies from a few ounces to 30-lb. and the machines in operation (Fig. 3) consist of Polak, Edgwick, and the latest types manufactured by Projectile Engineering Company, Limited. One of the outstanding features of this foundry is that each machine is fitted with a special filter to prevent any possibility of the residual oil igniting. All services are carried out below floor level, access being gained through special manhole covers and this leaves the shop clear and thus facilitates the use of mechanical-handling equipment for transporting finished castings and replenishing dies.

Tool and Die Department

This department, divided into the machine-shop and tool shop, is equipped for the manufacture of gravity- and pressure-die-casting dies, stamping dies, jigs, tools and fixtures, and general gauges used in the machine-shop and throughout the works. The equipment in the tool shop is modern, and is comprised of a range of machine-tools including a number of Universal milling machines fitted with copying attachments of various types. There is also a range of grinding equipment which enables the department to attain a very high degree of dimensional accuracy. A Ross projector is installed and this is used for the comparison of small radii forms and thread forms against a 50:1 projection.

Also to be seen are the inspection, laboratory and X-ray departments, and the chemical and spectrographic laboratories which are responsible for a control analysis of the four foundries.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

The British Non-Ferrous Metals Research Association was founded in 1920 and is this year celebrating 25 years' tenure of its present laboratory site. Its membership now totals more than 600 firms drawn from a wide field of producers, fabricators, and users of non-ferrous metals. Its income is derived largely from subscriptions from these member firms with a grant from Government funds proportionate to the amount of industrial income. In addition, the Research Association carries out a certain amount of research sponsored by Government departments.

The Research Association's work covers the whole field of non-ferrous metallurgy from problems of extraction and refining to questions of metal finishing and it should be made clear that work for the foundry industry is only a part, though an important part, of the total effort. The Association has a well-equipped experimental

foundry with gas-fired crucible furnaces, high-frequency furnaces and vacuum-melting equipment (Fig. 5). Equipment is available for shell moulding, for die-casting, and for the casting of ingots and billets for subsequent working including semi-continuous casting equipment. The foundry section, of course, operates amidst well-equipped metallurgical laboratories which provide facilities for X-ray and electron diffraction work, spectrography, metallography both by conventional means and by electron microscope, gas analysis, heat treatment, mechanical testing including creep and fatigue testing, and chemical analysis.

The main function of the Research Association is to provide facilities for the conduct of research into problems common to various groups in the non-ferrous metals industry, but, in addition to this, other services are made available to member firms without additional charge. These include a confidential technical enquiry service through which member firms and Government departments may consult the staff of the Association about problems concerned with the manufacture or use of non-ferrous metals. A department specially constituted to deal with these problems was established many years ago and is now staffed by six graduate scientists all with industrial experience who are backed up by the specialist knowledge of the experts in various fields in the Research department and who can call upon the services of the various sections of the Research department for any practical examinations required.

Other Services

In addition to this technical enquiry service, members have also the right to make use of the Association's information service and library. The information service deals with the kind of enquiries that can be answered immediately by reference to published information or recorded knowledge and functions separately from the technical enquiry service which handles those problems involving the application of practical "know how" or metallurgical investigations. Library loans to members now amount to about 10,000 each year.

The type of researches undertaken are those which will have a wide appeal to various sections of the non-ferrous metals industry and often consist of a fundamental investigation of an industrial process to obtain a better understanding of its functioning. This often leads to suggestions for improving the process or reveals entirely unknown aspects of the process capable of commercial exploitation. For example, in one of the foundry researches undertaken in the past it was shown that copper-base alloys sometimes undergo a metal/mould reaction when cast into sand moulds so that a certain amount of gas is absorbed by the metal. It has been shown that this reaction is sometimes capable of commercial exploitation to overcome difficulties of pressure tightness associated with concentrations of shrinkage porosity.

The ultimate responsibility for the researches undertaken lies with the Research Board whose membership is drawn from all fields of the non-ferrous metals industry. Five other committees, each dealing with a particular branch of the industry, are responsible for preparing each year detailed research proposals for submission to the Research Board and any member firm has the right to suggest subjects for inclusion in the research programme. The general progress of most researches is supervised by committees made up of individuals from the industry directly interested in the subject and able to contribute from their own experience. These committees play an important part in ensuring that the research remains linked with the practical needs of industry. The results of the research work carried out are issued in the form of confidential reports which all members are entitled to receive. The reports, however, are not sent automatically to member firms, but each month every member receive a copy of the B.N.F. *Review* in which the research reports which have been released in the previous few weeks are discussed in short articles emphasizing particularly the practical applications of the work.

The researches which have been carried out for the foundry industry during the past few years have covered among other things the melting of copper alloys and light alloys with particular reference to gas absorption and methods of de-gassing, metal/mould reaction undergone by molten alloys when cast into sand moulds, grain-refining both of aluminium alloys and copper alloys, casting characteristics of light alloys including factors affecting hot tearing in die-casting, and fundamental investigations of the thermal gradients developed in

FIG. 6.—*Pouring at the Belling iron foundry; the floor-bank system of mould storage is practised.*

FIG. 7.—*Double pouring of electric-cooker castings at the works of Belling & Company, Limited. On the left is a pattern for a cooker top-plate, and on the right a pattern for a cooker front.*

castings during solidification and the thermal properties of moulding materials. More recent investigations have concerned improvements in copper-base foundry practice such as the use of exothermic and insulating sleeves for feeders and methods of running and gating castings. A comprehensive survey has been made of the shell-moulding process covering the equipment available and the practicable application of the process, and work is in progress in the laboratories to clarify some of the conflicting views found in the course of this survey.

Belling & Company, Limited

Bridge Works, Enfield, is one of the largest factories in the world engaged solely in the production of electric fires and cookers.

The business was founded by C. R. Belling in 1912 and he commenced operations in a small garage, assisted by one man and a boy. His progress since those early days is well known and forms one of the romances of the electrical industry but it is worthy of note that, even after more than forty years, Mr. Belling will still be found in his office every day, directing and controlling the affairs of the company with the same unflagging zeal and enthusiasm responsible both for the creation of the company and the attainment of its present eminence in the industry.

In its present stage of development, Bridge Works completely covers a site of 10-acres and is a self-contained unit, comprising iron and aluminium foundries, vitreous-enamelling plant, finishing division, fireclay department, press shop, tool room, research department and assembly lines. The equipment throughout is of the latest type, consequently vitreous enamelling is carried out in the most up-to-date continuous enamelling plant, and castings and boiling plates are inspected by X-ray apparatus.

The press shop accommodates a battery of presses ranging from 20-ton to 300-ton.

The foundry occupies a floor area of approximately 30,000 sq. ft. and has a monthly production of 85-ton of grey iron and 8-ton of aluminium castings. This represents some 30,000 and 25,000 castings respectively, all of which are used in the production of electric fires and cookers.

As all iron castings have to be vitreous enamelled, the quality of the castings is necessarily high and the moulders take pride in the company's reputation for first-class finishes. Similarly, every attention is paid to the conditions in which the moulders operate and aluminium box-parts are extensively employed to reduce fatigue in lifting. A plentiful supply of facing sand prepared in a batch-type mixing machine is always available to the moulder, and a rotary-type sand mixer traverses every row, mixing and preparing floor sand after knockout, ready for the next day's work. The whole of the foundry is engaged in floor moulding (Figs. 6 and 7), with the exception of five snap-flask machines used to produce small castings.

Control

Metal control is strictly mantained and each charge into the cupola contains pig-iron and scrap of the same type and in the same proportion. The charge is made by hand in the same rotation so that an even mix is assured.

After sand-blasting, the castings are inspected and fettled before being passed to the machine shop for drilling where necessary. A large proportion of these castings is used in the production of electric cookers, which leave the assembly lines at the rate of several thousand weekly.

The "Belling" range of cookers comprises the No. 29 table cooker, No. 51 "Wee Baby" cooker, No. 45A "Baby" cooker, No. 53 "Big Baby" cooker, No. 47A Standard and No. 64AB Streamline cookers. All these cookers enjoy great popularity with the public, both at home and overseas, and the proportion of "Belling" cookers exported annually forms a very substantial percentage of the total cooker-exports from the United Kingdom. Production and sales of electric fires, space heaters, boiling rings, clothes-drying cabinets, food-warming cabinets, bed warmers, immersion heaters and towel airers, is also on a very large scale.

Morgan Crucible Company, Limited, Battersea, London

From the small factory opened in 1856, for the purpose of manufacturing crucibles, to the imposing factory buildings covering 11½ acres and employing 3,500 work people manufacturing many products, is the proud story of the Morgan Crucible Company Limited.

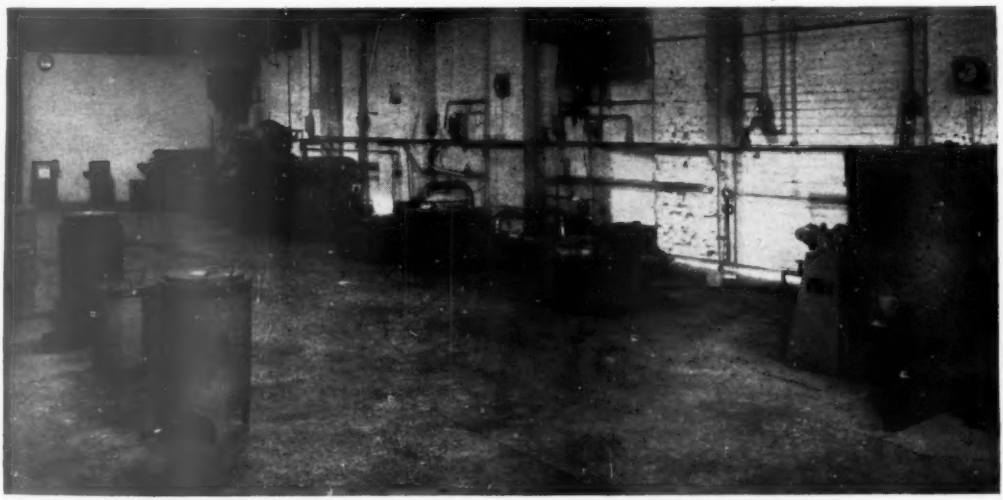
In the early manufacture of these crucibles, a wide knowledge of the properties of graphite and clay was obtained; this in turn led to the manufacture of other articles using either of these materials, similar processing methods or associated fields of application. Battersea is now the main factory and head offices of a group of companies covering the world, and making a diversity of engineering products and components. This short list summarizes the main products that are produced at Battersea works:—

Plumbago crucibles, refractories, carbon brushes for electrical machines, carbon engineering components, sintered metal products, lighting and welding carbons, carbon and graphite paints, lubricants, jointing compounds and graphite paints, chemical carbon and graphite, carbon refractories, radio and electronic components, silicon-carbide heating elements. In marketing this range of engineering components, Morgans is represented throughout the industrialized world by factories, sales and technical offices, agents and stockists appropriate to the local circumstance. Apart from several factories in the United Kingdom, overseas manufacturing facilities are available in Australia, South Africa, Canada, United States of America, Hungary, Italy, Spain, Brazil, Chile, Indonesia, Japan, Malaya.

FIG. 9.—*Section of the Battersea Wharf foundry of the Morgan Crucible Company, Limited, showing three of the new oil-fired type LO lift-out crucible furnaces. In the foreground are two of a battery of coke-fired type LO furnaces.*

The visit to the headquarters of this organization will cover four parts of the works; a new central research department, test foundries (Figs. 8 and 9), a manufacturing unit making carbon brushes and one making crucibles.

FIG. 8.—*General view of the experimental foundry at Morgans, Battersea Works.*



Founders "At Home"

Central Research Department

This department is housed in a new building and its purpose is to co-ordinate the activities of a research group, and engineering services group and a scientific services group. Here will be seen the many activities which are an essential feature in the research, manufacture and development of the range of products which are produced within the group.

Test Foundry

In addition to laboratory test and research activities the Company maintains a test foundry (Fig. 8) for more practical work in connection with their foundry products. One of the main purposes of this foundry is to test furnaces and crucibles.

FIG. 10.—*A section of the R. & A. Main floor-moulding foundry.*

R. & A. Main, Limited

Gothic Works, Edmonton, which delegates to this year's International Foundry Congress will be visiting on Thursday, June 23, is the North London factory of Glover & Main Limited. This group of Companies which comprises R. & A. Main Limited, Main Water Heaters Limited, Main Refrigeration, Main Enamel Manufacturing Company Limited, and Thomas Glover & Company Limited has also recently entered the washing-machine field by acquiring the whole of the share capital of Morley Products (Padiham) Limited, and now has a wider interest in the manufacture of gas-burning appliances than any other firm in the country.

In addition to its Edmonton works the company have factories at Croydon and Falkirk and have various other sub-assembly branch works

throughout the country. They also have subsidiaries in Holland and South Africa.

Gothic Works, Edmonton, commenced operation in 1899, two years after the amalgamation of Thomas Glover & Company Limited and R. & A. Main Limited, to form the present parent company of Glover & Main Limited. The original shop-area occupied in 1899 was a mere 62,000 sq. ft., today it is more than 677,000 sq. ft.—over ten times the area—and includes the factories of R. & A. Main Limited, Thomas Glover & Company Limited, Main Enamel Manufacturing Company Limited, and a pilot factory for the production of the new Main refrigerators. Even now, only about 15 acres of the 24-acre site are built upon, and ambitious plans are in hand for further development and expansion of the various factories.

The history of R. & A. Main Limited dates from the early eighteen seventies when the Argyle Ironmongery Company of Glasgow was engaged in the manufacture of cooking appliances. A restaurateur, Matthew Waddell became interested and with Robert B. Main—an ironfounder's representative—formed the firm of Waddell & Main. About 1884 Waddell reverted to his catering interest and R. B. Main was joined by his brother A. P. Main to form the present firm of R. & A. Main Limited.

Range Manufactured

Although the major business of the firm was still the manufacture of cooking appliances, many other forms of gas appliances were now included. Space heaters, gas fires, gas radiators and water heaters of both instantaneous and storage types were produced in ever-increasing numbers, necessitating successive removals to larger and yet larger premises in Glasgow. In 1897 came the amalgamation with Thomas Glover & Company Limited and the acquisition of the sites of the present factories at Edmonton and Falkirk.

Throughout its history the firm of R. & A. Main have played a leading rôle in the gas-appliance industry, pioneering many of the ideas which were later to be adopted as current trends by the whole of the industry. It is obviously impossible to mention all of these technical landmarks, and therefore but three examples of the companies' pioneer work are mentioned: the simplification of cooker construction in 1922-3; the production of the first, and then only, all-enamelled cooker in 1927; and the production of the first all sheet-metal cooker in 1935. To-day, the Main No. 20 "Century" cooker takes pride of place.

During their tour, delegates will be able to follow the manufacture of the "Century" and the many other "Main" gas appliances produced in this factory, from raw-material stage through the various workshops to final assembly and testing. Delegates will, however, be primarily interested in the firm's foundry departments of which there are two.

The floor foundry (Fig. 10), covering 30,000 sq. ft., can accommodate over 1,000 moulding boxes and is primarily used for castings required in smaller quantities than would prove economic on the mechanized plant. Including trainees, about 30 moulders are employed, each moulder making on an average between 22-34 boxes per day, depending upon the type of work. The present average weekly output for the shop is 18 tons of good castings.

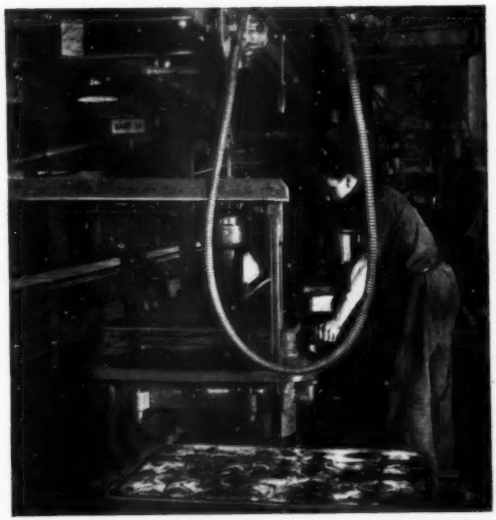


FIG. 11.—*One of the BI magnetic-moulding-machine stations (producing gas-stove frets) at R. & A. Main, Limited.*

The mechanized foundry, with an area of 22,000 sq. ft., has an output, when fully employed, of 60 tons of light castings per week (Fig. 11).

Considerable improvements have been made to this plant since it was installed in 1947 and as a result the cost of production is more than competitive with the floor foundry.

The plant is laid out in two identical halves to allow good flexibility in rate of production and give better accessibility for maintenance.

Hoover Limited

The story of Hoover Limited goes back to 1907, when, at North Canton, Ohio, U.S.A., a caretaker, the late Mr. Murray Spangler, made the prototype of the Hoover cleaner. The late Mr. W. H. Hoover, a manufacturer of the city, became interested in Mr. Spangler's invention and entered into agreement with him for the rights of manufacture and marketing. Hoover cleaners gradually became more and more used in the United States and made their appearance in Britain in 1919, when offices were acquired in central London with a total staff of six. The marketing of the cleaner in the United Kingdom had begun. On the scene at the beginning was a young ex-engineer officer, Mr. C. B

FIG. 12.—*Die opening and casting removal at Hoover's die-casting foundry.*

Colston, now Sir Charles Colston, C.B.E., M.C., D.C.M. He quickly saw the potentialities of the new product and became the leader of the organization which, before he retired this year, he had served for 35 years. With him from the early days was Mr. J. A. Wykes, now managing director. Together, throughout the years, they led the company from success to success.

Perivale Factory

At the factory at Perivale, Middlesex (Figs. 12 and 13), are produced the whole range of Hoover electric cleaners, and the Hoover electric polisher. Over 2,000 people work in this, the parent factory, which is also the administrative headquarters of the whole British organization. Built on a site of eight acres, the factory itself occupies 1¾ acres, which in turn provides 270,000 sq. ft. of floor space. In addition, there is a separate training and amenities building where are situated the personnel department, the engineering training school, sports club, offices, restaurants, and the rest and recreation rooms.

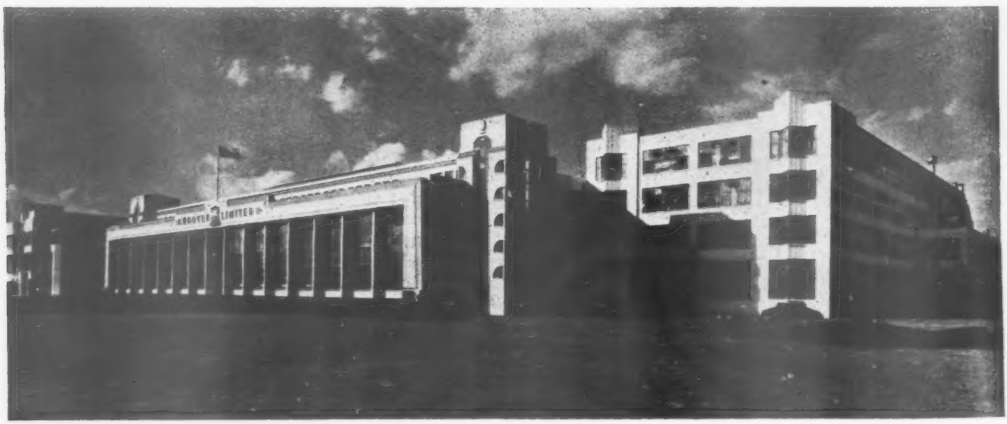
Ground Floor

The ground floor is mainly devoted to the primary processes in the making of cleaners and polishers. From one of the most modern die-casting foundries in Europe, a conveyor brings the metal castings for machining, scurfing and welding in the machine-shop. Lines of drilling, milling, grinding and capstan lathes finish to fine limits the various parts required, notably the armature shafts. There is a very high degree of mechanization throughout the whole building, fulfilling the double purpose of storage and of making each part immediately available to the operators as required. In this part also is the plastics section.

Assembly

Metal parts from the ground floor are taken to the first floor and are plated, polished, enamelled and sprayed prior to assembly. Here also lines of women operators wind armatures at high speed on specially-designed machines. The finished-wound armatures then have commutators pressed on. Final machining of the armatures and their balancing tests follow and the "agitator" parts are also put together at this stage. The tool room at Hoovers' Perivale works is one of the most modern and well-equipped in the London area. Also on this floor is the main-production line for the electric polisher, and here, too, are made the bags for the cleaners, with machine-cutting of cloth in vast quantities and lines of electric sewing-machines. The third floor includes the model shop where all Hoover prototype models are built, and the engineering drawing office. Also there are the

FIG. 13.—*Outside view of the Hoover factory at Perivale.*



electrical, metallurgical and chemical laboratories, where scientific tests and research are going on all the time.

In a special test room, completed products selected at random are submitted to the most exhaustive tests. The products are run day and night for periods equal to many times their normal life. Cleaners are deliberately abused by being made to bump their way for hours at a time over metal rods. Apart from these special tests, stringent inspection to known standards and testing take place in every component at every stage of manufacture, while every product is mechanically and electrically tested before packing.

K. & L. Steelfounders & Engineers, Limited

K. & L. Steelfounders & Engineers, Limited, are one of the " 600 " Group of Companies, the parent Company of which is George Cohen, Sons & Company, Limited. They are one of the larger steel foundries in the United Kingdom, having an output of some 11,000-tons of steel castings each year. Additionally large engineering shops, while largely devoted to the manufacture of the famous Jones mobile cranes, provide machining capacity for many customers who prefer to buy their castings in the rough or finished-machined condition. The works are in the first garden city of Letchworth and occupies a 64-acre site, of which some 16 acres are covered with buildings. The total personnel of the Company is 1,700, of whom roughly half are engaged on steelfounding and half on engineering. The foundry has tended, for the purpose of rationalization, to concentrate on medium batch production castings ranging from 40-lb. to 4,000-lb. in weight, although facilities exist for castings outside this range, and they are frequently undertaken when the production programme permits (see Figs. 14 to 16).

While the foundry serves a wide range of industries, is has a special interest in steam and electric locomotive work and also has large customers in the earth-moving and mechanical-handling industry. A wide range of carbon and low-alloy steels is produced, and a fairly substantial tonnage of 14 per cent. manganese-steel castings is also made.

Patternshop

The K. & L. patternshop (see Fig. 16) is a relatively modern building both in construction and layout. Prominent features are the teak parquet flooring, underdrawn roof and radiant panels, steam heated in the ceiling and the west wall, and full height glazing to the north and east walls. All the wood-working machines have dust extraction which runs underneath the parquet flooring to a cyclone dust arrestor outside the building. This system of underground extraction—though greater in first cost —gives no obstruction to light and working space, which is inevitable in the more common overhead dust-extraction systems. A metal-pattern section adjoins the patternshop, and adjacent to it is one of the five large pattern stores. The whole building is equipped with a modern sprinkler-system to cover the fire risk.

The foundry has devoted itself largely to those classes of steel castings where accuracy of dimensions, quality of surface finish, and, above all, internal soundness, are of paramount importance for the duties they have to undergo in service. To this end, there are large and well-equipped metallurgical laboratories, both for research and control purposes,

FIG. 14.—*Dispatch end of the dressing shop at K. & L. Steelfounders & Engineers, Limited.*

FIG. 15.—*One of the Birlec "Lectromelt" arc melting furnaces at the K. & L. foundry.*

and the radiographic laboratories have five sources of X and gamma ray in constant use, largely for prototype work and routine testing. The laboratories consist of separate sections for metallography, experimental heat treatment, sand research, and sand testing as well as the radiographic laboratories and laboratories for general chemical analysis.

The steel-melting shop covers an area of some 20,000 sq. ft. and embraces bins for storing about eight grades of scrap. The whole area of the melting shop is covered by overhead cranes, and full mechanical-handling of the steel from the incoming rail or road trucks with scrap to the final liquid-steel to the foundry ensures low man hour per ton in the steel-melting process. After tapping, the steel is transferred to the appropriate bay in the steel foundry by power-driven transfer bogies.

The melting units (Fig. 15), at the present time, are two 5-ton Birlec "Lectromelt" arc furnaces, basic-lined and each powered with a 3,500-kva transformer. They normally produce about 450 tons of liquid steel each week, but there have been many occasions when outputs of 550 tons of liquid steel in seven days have been produced from these two units. K & L were one of the earliest foundries in the country to adopt oxygen-blowing as a standard production practice to reduce the time for "boiling down" and give a more vigorous "boil."

The main foundry building covers approximately 100,000 sq. ft. and consists of four bays with many auxiliary buildings. Two of these bays are devoted entirely to machine moulding, one jointly to machine moulding and floor moulding, and the fourth to shotblasting, dressing, heat-treatment, and inspection.

Coremaking

The large cores are made, in the main, by skilled men on the open shop floor, but a highly-mechanized coreshop is producing 100,000 cores per week. A pendulum conveyor serves the benches, delivering sand (in bottom-heavy catchless buckets) and core plates, formers, etc., and bringing away, to be loaded in one of two continuous drying stoves, the completed cores. Coreblowing machines are in full use together with other mechanical aids. The cores are checked, jointed if necessary, and painted, after removal from the drying stoves.

Shotblasting is carried out in cabins, working on a pressure of approximately 90 lb. per sq. in., and in Tablast and Wheelabrator plants for the medium-to-small castings. Castings then pass up through the fettling shop through the normal processes of cutting-off, fettling, and grinding.

Heat-treatment is carried out in Buell furnaces fired by pulverized fuel for annealing, and in a batch

FIG. 16.—*Patternshop of K. & L. Steelfounders & Engineers, Limited. All the woodworking machinery shown has dust extraction running beneath the floor to a cyclone dust-arrester outside.*

of four 170/240kw. electric Birlec furnaces for normalizing and tempering. Loading and unloading of the furnaces is effected by mechanical charger.

The foundry machine shops are equipped with boring mills and faceplate lathes for machining all sizes and types of wheel centres, and with other machine tools for locomotive and a general range of castings to be supplied rough, or finished, machined.

A large extension to the foundry is approaching completion. This consists of a new Portal-type steel-framed building in three bays, having an area of 60,000 sq. ft. New melting units are a 600kva. Birlec high-frequency unit with two 1¼-ton bodies and one 5-cwt. There is also installed a third 5-ton Birlec "Lectromelt" arc furnace, basic-lined, with 3,000kva transformer. A complete new sand system is being installed in this extension, together with its own coreshop. It is intended to make most of the smaller repetition castings in this new shop.

In addition to the production facilities described, the K & L foundry is well to the forefront in the provision of amenities. Extensive and well-equipped bathing and washing facilities with locker rooms and complete with their own laundry have been in use for some years, and a new and similar block is being put up alongside the new foundry extension.

The canteen and social centre occupies a 2-acre site opposite the main gate, and the company has a well-equipped first-aid station with consulting and examination rooms for the doctor and matron in charge.

The company is deeply interested in the export market as not only does a large proportion of the Jones mobile cranes produced go directly to the export market, but the greater proportion of the steel castings made ultimately finds its way overseas also. In addition to seeing the extensive steel foundries, visitors will have the opportunity to see modern engineering shops devoted to batch production of heavy mechanical-handling equipment, much of which is used in foundries and steel plants throughout the world.

Langley Alloys, Limited

Shortly before the last war, it was foreseen that new applications for materials in the manufacture of many precision components would necessitate the formulation of new alloys having unique properties. In anticipation of this demand for high-duty materials, a company was formed with the object of producing special copper-alloys. From these beginnings, Langley Alloys Limited was founded as an independent company in 1939, and it is significant that many of the original alloys are still in regular production and remain unsurpassed in the applications for which they were designed.

During the war, the demand steadily increased and the range of alloys was extended to include certain nickel-alloys. In the post-war years the production of nickel-alloys rose sharply and in addition the manufacture of austenitic stainless-steels was undertaken.

Strict laboratory supervision is exercised over all raw materials entering the company and over manufacturing and processing techniques; in particular, the proprietary alloys are subjected to routine analyses and checks as they progress through the foundry.

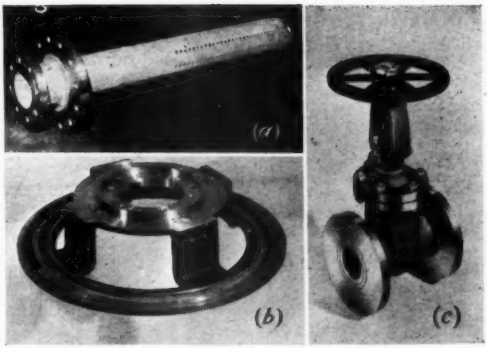


FIG. 17.—*Components made by Langley Alloys, Limited: (a) A 6-in. bore steam nozzle in Langalloy 6R; (b) Instrument gear machined from a stamping in Hidurax aluminium-bronze and (c) A gate valve in Langalloy 3V stainless steel.*

Foundry

The foundry is equipped to produce a wide variety of castings ranging in weight from a few ounces to several thousand pounds. Castings are hand-moulded, machine-moulded or shell-moulded, depending upon their size and the quantities in which they are required.

Hidurax Aluminium-bronzes and Hidurit Manganese-bronzes

Components weighing up to 3,000-lb. can be cast in these materials at Langley. Special attention has been devoted to the problems associated with the casting of pump cases, impellers and similar accessories, particularly for centrifugal pumps. Valve bodies in aluminium bronze up to about 100-lb. wt. are also a speciality. The range of products cast in aluminium bronze at Langley Alloys Limited is very wide indeed, including large gear-blanks, aircraft components, marine fittings, paper-making machinery, engine selector forks and food-processing machinery. Complete fluid control valves are available in Hidurax 1 aluminium bronze-Y-type, globe, gate, needle and check valves and strainers (Fig. 17 and 18).

Gunmetals and Phosphor-bronzes

Castings weighing up to 3,000-lb. are available for applications such as pump cases, bearings, gear blanks, bodies, etc.

High Conductivity Copper (85 per cent. IACS)

Castings for the electrical industry, weighing up to several hundred pounds for applications such as switchgear parts, busbar connections and transformer secondaries.

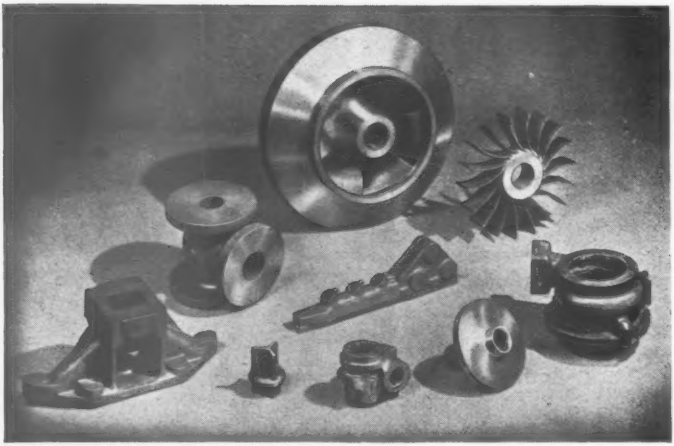


FIG. 18.—*Group of components cast at Langley Alloys, Limited, in various special bronzes. The large impeller is manufactured in Hidurax aluminium-bronze, an alloy outstanding for its resistance to wear and cavitation-erosion.*

Hidurel Copper/Chromium Alloys

Possessing greater strength and durability than cast copper, the Hidurel copper/chromium alloys yet retain remarkably high electrical (*e.g.*, 80 per cent. IACS) and thermal conductivities. They are widely used for resistance welding electrodes and accessories, switchgear and many applications in mechanical engineering practice.

Langalloy Stainless Steels and Nickel-base Alloys

Employed for duties necessitating high resistance to corrosion or for ensuring high purity and freedom from contamination, these alloys are available as castings. Complete ranges of fluid control valves are manufactured in Langalloy materials as specified under the heading "Hidurax Aluminium-Bronzes and Hidurit Manganese-Bronzes." Other applications include valve bodies, pump cases, impellers, flanges and pipe fittings.

A similar range of castings and cast products is also made in Monel, Nickel and Inconel.

Rolling Mill and Forge

The installation of a new and larger rolling-mill is nearing completion. This will extend the facilities for the production of bar in the copper-base alloys; increased lengths and diameters of rolled bar will shortly come into production.

Langley forgings and stampings in copper-base alloys are already widely known and are employed in countless applications requiring high-duty materials. All necessary dies and tools are produced within the company and considerable savings can be effected by taking advantage of full consultation at the design stage, since minor amendments may greatly facilitate economic production.

Co-ordinated Service

The company has its own machine shop, pattern-shop and drawing office; each is well equipped and thus contributes to the fully co-ordinated service which is available to all customers. The pattern-shop is equipped to produce patterns for shell-moulded as well as hand-moulded and machine-moulded castings.

The Langley technical service has had long experience in the application of the firm's special alloys and authoritative technical advice can be obtained on all matters concerning design and selection of materials. The company's development engineers who are available for consultation at Langley or elsewhere are in touch with the latest advances in all branches of industry and a vital exchange of information on materials and requirements is provided.

Bagshawe & Company Limited

Bagshawe & Company was established at the end of the 19th century. In the early days American malleable-iron chain was factored. Later, after building the works at Dunstable in the early 1900's the company manufactured and sold its own chain.

The business developed along natural lines, first, into the field of simple elevators and conveyors; and, finally, to the design and manufacture of a wide range of mechanical-handling equipment, which includes foundry plant.

Visitors will be able to see the foundry in which the whiteheart malleable-iron chain castings are made, together with other castings in this material which are sold to a variety of users.

Cupola and sand practice are both laboratory controlled. The equipment includes a continuous sand-preparation plant and a delivery system both of which are of the company's own manufacture. The majority of the work is of a light character, and is made in snap flasks from double-sided matchplates.

Visitors will also be able to see chain assembly and the building of a variety of handling equipment. The company's staff has, over the years, obtained a very wide experience, and there will be opportunities of discussion of material handling problems.

Morris Singer Company Limited

Situated within walking distance of the celebrated Oval cricket ground, the Morris Singer Company, Limited, specializes in making bronze statuary for the leading artists of the day. They

also do a limited amount of casting in the precious metals. The latest major work to be made in this foundry was Sir Jacob Epstein's group "Social Consciousness," consisting of two groups each 13-ft. high and one seated figure 10-ft. high. The contract was obtained from the Fairmount Park Art Association, Philadelphia; the work has been erected on a temporary wooden-base in front of this art gallery before installing the bronzes in their permanent quarters. This work (Fig. 19) has received the acclamation of American art lovers.

Two important works now being cast are the national memorial to the late King George VI, 9-ft. 6-in. high, by William McMillan, R.A., and the Great Menorah (7-branch candlestick) 12-ft. 6-in. high by 14-ft. 9-in. spread, by Benno Elkan, the contract obtained from the Menorah Committee, possibly to be erected in Israel.

An example of the firm's finished bronze-work is a group of Saint Christopher by Gilbert Ledward, R.A., exhibited in this year's Royal Academy Exhibition, this group is to be erected outside the Hospital for Sick Children at Great Ormond Street. Two large seated figures, Old Man History and The Lady with a Thread, by Francis Shurrock of New Zealand, are ready for despatch to that country for the Centennial Memorial Committee, Otago, 1848-1948 to commemorate the colonization of that country.

In 1954, bronzework was made and despatched to the following countries: America, Australia, Canada, China, France (for the American Battle Monuments Commission), Iceland, New Zealand, Russia, Southern Rhodesia, Union of South Africa.

The Morris Singer Company are proud to have produced the Roosevelt statue in Grosvenor Square and the casting and installation of the fountains in Trafalgar Square by Charles Wheeler, O.B.E., R.A., and William McMillan, R.A.

Among their larger works are the bronze doors at the Bank of England.

Among the smaller ornate pieces of work is the mace which is carried at the head of the chief ceremonial-processions at Westminster Abbey. Cast in bronze, gilt and silver-gilt, with shields in vitreous enamel, it was designed by Kruger Gray, the model being completed after his death by Benjamin Clemens.

The foundry was started by John Webb Singer, a noted silversmith of his day, about 150 years ago, at Frome, Somerset, when he persuaded some French and Belgian bronze founders to work in

FIG. 19.—*Sir Jacob Epstein's Group "Social Consciousness" made in the foundry of the Morris Singer Company, Limited.*

FIG. 20.—*One of the main bays in the new foundry of A.P.V.-Paramount, Limited, showing some of the coremaking benches in the foreground.*

this country. Their first big job was the Boadicea Statue on the Thames Embankment, by T. Thornycroft, R.A., and from this commencement the local boys were trained to be statue moulders, chasers and fitters. Later on, the bronze figure of Justice with the famous scales was cast and can be seen on the roof of the Old Bailey, the Courts of Justice.

In 1932, the foundry part of the business was transferred to London, linking up with William Morris, the well-known stained glass and ecclesiastical firm.

Due to the scarcity of building ground, the foundry must naturally be on the small side. Also, other than the usual mechanical aids such as electric cranes, gyratory riddles, etc., the craft, both the sand process and the *cire perdu*, is carried on by craftsmen in much the same way as it was in the earliest days.

It is very difficult to gauge accurately the weight of castings each week as some of the huge moulds may take 3-4 months to produce before a pour takes place.

In addition to the statuary, Morris Singer produce architectural castings for fronts of buildings, etc., and also have a small commercial-bay to produce gear-wheels, machinery parts, etc., for their subsidiary companies.

Connected with the organization is an iron foundry operating as the S.E.M. Foundry, Pitsea Street, Stepney.

Lake and Elliot, Limited

Mr. W. B. Lake began business in Braintree as a cycle dealer in 1892, and manufactured tool-kits and accessories for the cycle trade. In 1896, he was joined by Mr. E. Franklyn Elliot, and they began to manufacture tool-kits for the motor-car industry, eventually specializing in the production of jacks.

Mr. Lake had had previous experience of ironfounding, and came to the conclusion that iron founders were charging him too much for his components! He therefore built an iron foundry on the site of the present works in 1905, to make the castings for the jacks, and also for general ironfounding. He soon came to realize, however, that the iron foundry he had built was too big for the potential sales, and therefore made up his mind to enter the steel-castings industry. After studying methods in Germany and France, Mr. Lake purchased a Héroult electric furnace, which was installed in Braintree, and in 1911 sold the first production steel-castings to be made in the UK from an electric furnace. In 1917 an up-to-date powerhouse was completed, which not only supplied the requirements of the electric furnaces and the rest of the works, but also neighbouring industries and the townships of Braintree and Halstead.

Engineering shops were added at a later date, and Lake & Elliot Limited became one of the first companies to offer machined steel castings to its customers.

In 1926 Lake & Elliot Limited were the first company in the UK to instal a high-frequency furnace for the production of commercial steel castings. In the early 1930's the company pioneered the introduction of cast-iron brake drums in the motor industry in this country.

Mr. W. B. Lake was president of the Institute of British Foundrymen in the years 1939 and 1940.

In 1947 the powerhouse was closed down, and electricity was supplied from the "grid." A most efficient control system for the supply was installed, involving power factor correction and maximum demand control. At this time negotiations were opened with the Key Company of East St. Louis, Illinois, USA, which resulted in an agreement whereby Lake & Elliot Limited produced Millennium-Key fittings for the oil-refinery and chemical industries.

The boilerhouse of the old power station has been converted into a highly-mechanized iron-foundry for the production of castings for their hydraulic and screw jacks. A new patternshop and store, a new warehouse, a new machine shop,

a modern surgery, a social-club pavilion and a garage building have been erected since the 1939/45 war, as well as numerous extensions to existing buildings. Items of especial interest to the visitor are the electric heat-treatment layout and installation, and the gamma-ray procedure carried out by the inspection department.

APV-Paramount, Limited

The parent firm, A.P.V., Limited, is one of the largest manufacturers of plant in stainless steel, aluminium, and copper for the dairy, brewery, food, chemical, and associated industries. It was founded by Dr. Richard Seligman in 1910 as the Aluminium Plant and Vessel Company, Limited, for the fabrication of industrial tanks and vessels in aluminium. A.P.V.-Paramount, Limited, was formed in June, 1952, and moved to a new factory and foundry built in the new town at Crawley. The factory and foundries occupy a 17-acre site, and cover 200,000 sq. ft. They form entirely separate blocks with their own administrative offices. The factory block covers 128,800 sq. ft. and consists of five 475-ft. bays. The layout provides for a general flow of production. The machine, press, and polishing shops stretch across all bays, while the fitting shop occupies most of the large 60-ft. bay and one other (see Fig. 20).

The foundry building consists of two 60-ft. main bays, 250 ft. long, one for the stainless-steel section, and the other for aluminium and copper-base alloys. A 20-ft. middle bay houses the furnaces and their auxiliary equipment, including the generators. The stainless-steel furnaces are electric high-frequency and arc types, while the aluminium furnaces are oil-fired. Offices, stores and pattern-shops occupy the frontage of the building and the fettling shops the rear end. X-ray and other test rooms run along the side of the aluminium foundry. A large fume and dust-extraction plant is installed and the working conditions are bright and clean. A number of development projects recently carried out at the foundry include a section devoted to shell moulding.

Austin Motor Company Limited

The first Austin car was made at the Longbridge factory early in 1906. It was a touring model with a 4-cylinder engine rated at 25 to 30 h.p.—a tremendous advance over the horseless carriage style and the early Austin designs of 1895 and 1900. In the modern Longbridge factory, with its own railway sidings, station and loading bays, 5 miles of roadways, restaurants, medical and welfare services and electric-power plants, more of the complete process of car manufacture takes place than in any other single British plant. To this comprehensive quality it owes its exceptional interest as well as efficiency, for visitors can see virtually the complete flow of motor-car production. Here can be seen not merely the assembling of units and parts derived from widely different sources, not only the machining processes, but the initial preparation and shaping of the raw materials and every subsequent stage of manufacture. Austin cars are conceived

FIG. 21. — *Multiple machining techniques for cylinder-block castings at the Austin Motor Company, Limited.*

in the styling department where new body styles are first sketched, then modelled in Plasticine. Full-scale drawings are next made and wood models constructed to actual size. Meanwhile chassis designs are being produced to meet the required specifications of the new car, and the result is the building of a complete prototype vehicle. Many months are then spent in testing, modifying and re-testing every major component as well as the complete vehicle in order that the finished car will be equal to the most exacting conditions of operation, and provide long-lasting dependability.

Foundry

The raw material for many of the chassis parts first begins to take shape in the Austin foundry. Some 270 tons of finished castings are made in a week, but by no means all components are cast, some being made in the drop-forging shop. The Austin foundry has fostered the development of several innovations in practice, notably water-cooling of cupolas and the use of compacted steel scrap. After fettling, the castings and forgings pass to the machine shops where the surplus metal is removed and contact faces variously machined and ground. Obviously machining must be carried out within very fine limits, and parts are carefully inspected to see that the standards have been achieved. The various diameters of the camshaft, for instance, must be correct to 0.0005 in. if the assembled engine is to run smoothly and silently (Fig. 21).

Marshalling and Selecting for Assembly

Completed parts are next brought together in marshalling areas, and on their way to the assembly sections, pass through steam-washing machines to ensure absolute cleanliness. The assembling of major units such as the engine and gearbox is carried out behind glass partitions to afford protection from dust, metallic particles, and other contamination resulting from nearby machining operations. After a thorough testing, the assembled units are hung on special cradles from overhead chain conveyors (there are 16 miles of them) and flow in continuous succession from their individual factories within the vast Austin works to a mechanized central area. From there they are automatically selected in correct sequence and started on their journey to the car-assembly building through a great underground passage accommodating six conveyor chains—three going up loaded and three returning the empty cradles. From the main tunnel, and still below floor level, the units are switched into sidings which house a complex network of sorting gear. Here they are held in readiness until an automatic device moves them singly and in their right order on to elevators which lift them through the main floor to the appropriate assembly lines. This automatic system of control which operates from the sequencing area to the actual time of assembly, ensures that a given component reaches a point above its predestined chassis at precisely the right moment without being touched by hand. Skilled operatives using strategically-placed batteries of air-operated hand tools complete the assembling of the chassis.

As each car proceeds down the assembly line details of its major components are flashed to the documentation office by means of automatic recorders operating on electrical impulse. Thus, all essential data are immediately available, enabling release papers to be completed in advance of the vehicle's final inspection and test. The estimated capacity of the Austin car-assembly building is 4,000 vehicles a week.

Austin bodies, beginning as flat steel sheets, are processed in the firm's own press shops. There are approximately 800 welding points on each Austin body. Completed body shells are sent through a 500-ft. Rotodip system which in turn removes all grease, provides a phosphate coating to prevent corrosion, applies primer paint, and bakes the primer on to the body. After this preliminary treatment, the bodies travel through a huge painting plant and here the synthetic enamel is sprayed on and then baked in gas ovens at a temperature of 240 to 260 deg. F. Meanwhile in another section of the body factory, upholstery is being made, fascia panels prepared, roof linings and carpets cut to shape, and window glasses, dust-proofing strips and many other parts marshalled. Testing, adjustment, cleaning and inspection of the now complete new Austins finally prepare them for the road.

British Piston Ring Company, Limited

The principal products of the British Piston Ring Company are pistons, piston rings, gudgeon pins, cylinder liners, valve-seat inserts, valve guides, supplied chiefly to the automobile industry, but also to internal-combustion-engine builders and other branches of the engineering industry. A separate unit makes drill bushes for general engineering purposes, and this section also supplies

FIG. 22.—*General view of centrifugal-casting foundry of the British Piston Ring Company, Limited.*

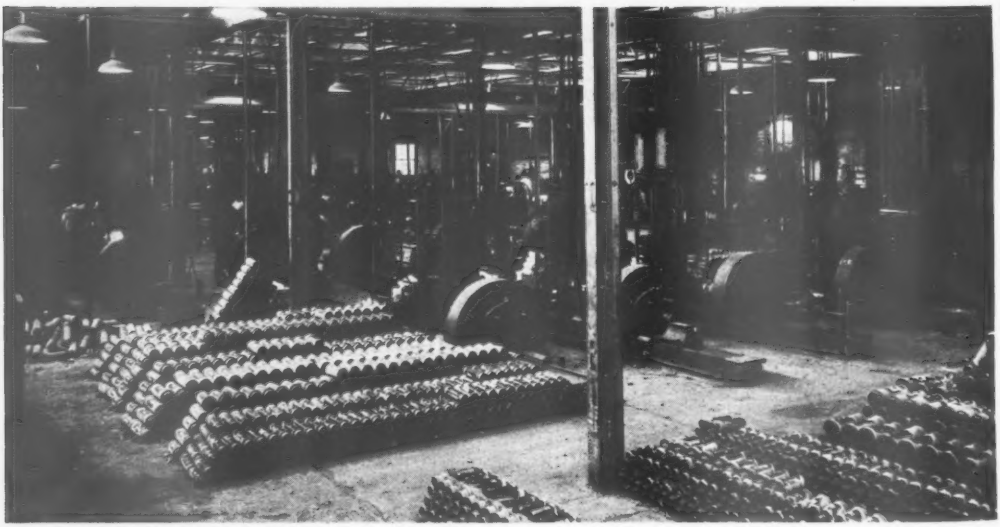


FIG. 23.—*After the moulds are made, they are brought by conveyor to the pourer. Molten metal is taken from the cupola by ladles which run on an overhead monorail to reduce fatigue and lessen the risk of accidents. The cupolas are designed to give a continuous flow of metal throughout the day.* (*Midland Electric Manufacturing Company, Limited.*)

foundry equipment in the shape of moulding-box bushes.

Foundries

The foundry, on which the visit will be centred, exists chiefly to provide castings for the finished products mentioned, although a considerable portion of the foundry output goes to outside customers.

The business originated in 1909 under the late Mr. W. A. Oubridge, father of the present managing director; from small beginnings, it has now grown to a group employing 1,400 people, of which approximately 240 are foundry workers.

The foundry buildings are situated approximately one mile from the main works, and comprise two sections approximately equal in size, but differing considerably in tonnage; that devoted to centrifugal casting for the production of piston rings, cylinder liners, valve-seat inserts, etc., giving a considerably higher output per square ft. of floor space than the sand foundry, which manufactures chilled-iron tappets, valve guides, valve-seat inserts, cast-iron bar and chilled-iron rockers.

The centrifugal foundry (Fig. 22) contains an impressive battery of casting machines, most are for castings up to 6-in. dia., with a few machines handling much larger diameters. Most of the casting machines are to the company's own design and are of the ejector type. This foundry is equipped with two Birlec 3-phase arc furnaces which are used as metal receivers, two small Birlec Detroit rocking-arc furnaces used for highly-alloyed materials including a 30 per cent. chromium iron type. The foundry is well served with monorail metal conveyors. Two Incandescent gas-fired furnaces are used for heat treating special materials, including the high chromium iron type, and abrasive wheel cutting-off machines are used for parting off the discard end of the castings.

In the sand foundry, small three-station Sandslinger units are provided for green-sand moulding; there are, in addition, jolt-squeeze machines, and a magnetic moulding machine is used for valve-seat inserts, the shallow boxes being "stack moulded" eleven boxes high and poured through the central downgate. Coreblowing is extensively practised for oil-sand cores and shell moulding is being introduced for a number of parts. A particular feature is the casting of chill-face tappets where very close control on depth of chill is required. This foundry is also equipped with a Birlec rocking-arc furnace, in addition to cupolas which provide the bulk of the molten metal supply. The specialist nature of the castings involves a high degree of material control, for which the metallurgical staff is responsible. Dimensional requirements are very exacting, as many of the valve guide and tappet castings are finished with only a bare grinding allowance. This calls for highly accurate equipment of all kinds and the closest possible control of the manufacturing operations.

A considerable volume of the firm's products, chiefly finished pistons, piston rings, gudgeon pins, etc., is exported directly, but there is, of course, a very much larger indirect export business in the way of parts fitted to motor-cars and engines sold abroad.

Midland Electric Manufacturing Company, Limited

For nearly 50 years the Midland Electric Manufacturing Company, Limited, has specialized in the manufacture of electrical switchgear and motor control gear and to-day it is one of the most highly organized and most frequently visited factories in the Midlands. Founded in Conybere Street, Birmingham, in 1908, the steady expansion of M.E.M. has led to various moves, first in 1910 to Rea Street South, then to Barford Street. The present 14-acre site was purchased in 1936 and extensions were completed in 1939 and 1953.

Last year, an additional factory site was acquired at Redditch; building is well in progress

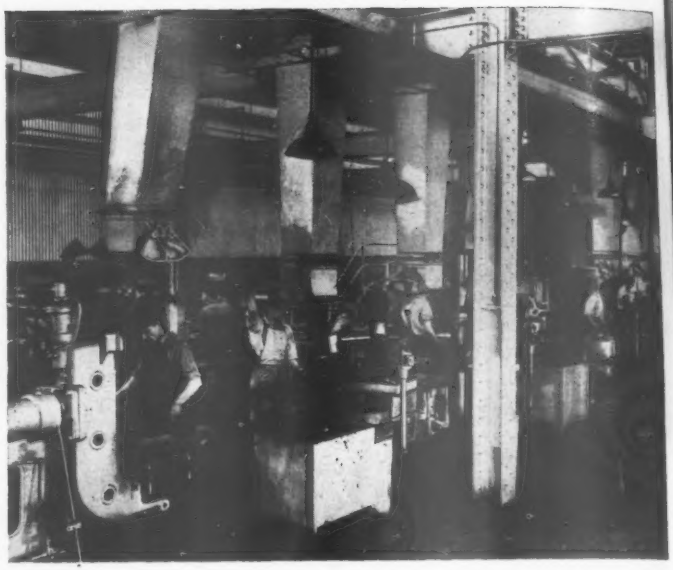


FIG. 24.—*One of the moulding plants in the Midland Electric mechanized foundry. The machines in the foreground work in pairs, producing the upper and lower half of the mould, respectively. Sand is brought to the hopper above the operator by overhead conveyor and by means of the lever at the side of the hopper he can withdraw just the amount of sand required for a mould. Further along the line are seen machines capable of producing a complete mould. The average time taken for production of a complete mould on these machines is under one minute.*

and the works will be equipped with the most modern plant. It is planned that this factory will be devoted entirely to the production of domestic heating appliances and will relieve pressure on working space at the Tyseley works, where switchgear and motor control gear is scheduled for further development.

The idea of a self-contained organization has been apparent from the beginning and can be traced back through the years, the introduction of an iron foundry and porcelain works in 1924 and 1925 being major steps in this direction.

The installation of a metal-extrusion mill in 1953 brought further economies in the manufacture of non-ferrous components, including contacts and terminal blocks. New methods of producing basic parts of M.E.M. products are constantly being sought and to-day, castings, porcelain and plastic mouldings are manufactured in vast quantities by special-purpose machines, within the Tyseley works.

The manufacture of nearly 1,000 catalogue items demands a high degree of internal organization and closer examination of two of the more interesting works departments gives some idea of the productive capacity which has been built up over the years.

M.E.M. is unique in having its own porcelain works. The clays and basic materials are obtained from Devon and Cornwall, and some are imported from Sweden. All the press tools for the moulds are made in the M.E.M. toolroom and the clay "body" is moulded into shape by hydraulic presses. After pressing and preliminary drying the "flash" is removed and the pressings are glazed and cleaned ready for firing. Girls working on either side of a conveyor carry out the fettling and cleaning and each working place is provided with air extraction to remove dust from the atmosphere. Glaze is sprayed on automatically before the final cleaning and inspection operation. The pressings are finally loaded onto trucks and moved slowly through the 130-ft. kilns, the complete journey taking 40 hours. Town gas is used to obtain the temperature of 1,250 deg. C. needed for firing and the daily consumption is in the region of 70,000 cub. ft. Well over a million pieces of porcelain are fired in the continuous tunnel kilns which are in operation 24 hours a day, seven days a week. The M.E.M. pottery works relies entirely upon local labour and the highly-skilled operatives are all trained within the department.

Foundry

When the present factory site was first occupied in 1937, a new foundry was built and, in order to produce 60 to 80 tons of light electrical castings per week, it was necessary for this to be a highly-mechanized production unit. The average weight of the castings is 2 lb. and a variety of moulding machines are in use, some working in pairs producing the upper and lower halves of the moulds and others capable of producing complete moulds. Sand is brought to the hopper of all machines by overhead conveyor. The rate of production is one mould per minute, per man (Fig. 24).

After the moulds are made they are brought by plate conveyor to the pourer (Fig. 23). Molten metal is taken by the "syphon brick" method of tapping from the cupolas, which are of the "balanced-blast" type.

At the "knockout station" the conveyor plate carrying the boxless moulds tilts automatically, tipping the mould onto an "apron-plate" conveyor, thus enabling the casting to be lifted clear of the sand. The casting is then sent for cleaning and fettling, the sand being re-conditioned and fed to the overhead conveyor for use again. Cleaning,

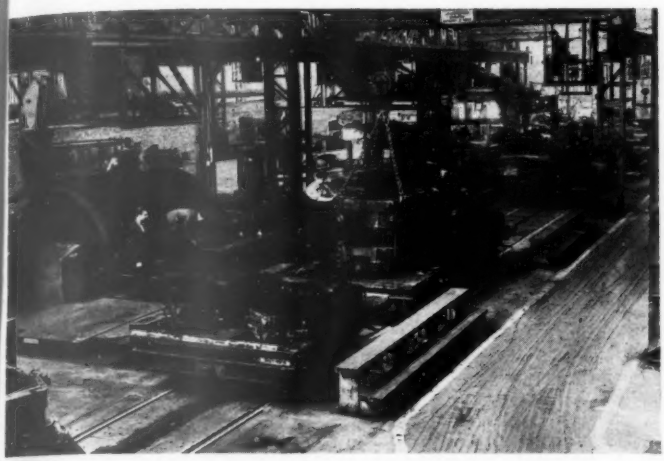


FIG. 25.—*View of one of the mechanized foundries at Stanton Ironworks Company, Limited.*

fettling and grinding is carried out in the main foundry building, the layout of which provides an excellent example of flow-line production. Some 80,000 castings are supplied weekly to the factory assembly-units and a very high standard of finish is maintained.

Every facility is provided for the maintenance of good working conditions and the M.E.M. foundry is, without doubt, one of the cleanest in the Midlands.

The principles of standardization of products, and simplification of design have been thoroughly applied, and this highly-specialized unit is typical of the many that make up the self-contained organization of M.E.M.

Stanton Ironworks Company, Limited

The Stanton Company are well known as large-scale producers of spun-iron pipes and also as the largest makers of foundry pig-iron in Great Britain.

The main works of the Stanton Company are situated at Stanton-by-Dale, 8 miles from Nottingham, and some 4,800 men are employed there in the various sections which comprise :—

Blast furnaces and ancillary plants, coke ovens, spun-pipe plants, mechanized and jobbing foundries, and a large concrete plant.

In addition to the manufacture of spun-iron pipes and pig-iron, other main products of the company include coke and related by-products, vertically-cast iron pipes and pipe specials, tunnel segments, ingot moulds and bottom plates, spun-concrete pipes, concrete lighting columns (both reinforced and prestressed), concrete pipe specials and other concrete products, large quantities of refined pig-iron and slag (treated and dry are also produced).

The latest development of this company is a completely new plant for the production of pre-stressed concrete pressure pipes.

Time will not permit visits to all sections, but visiting foundrymen will see manufacture of cast-iron spun pipes on one of three spun plants where pipes are produced for the gas and water industries in all sizes up to 27-in. diameter and in 12-ft. and 18-ft. lengths.

Also to be inspected is one of the company's large mechanized foundries (Fig. 25), and visitors will be able to see the production of component parts for the Stanton screwed-gland and Stanton bolted-gland flexible joints; pipe specials up to 27-in. diameter, and tunnel segments. All moulds in this foundry are made on turn-over or down-draw moulding machines and are rammed by impeller-type machines.

The Stanton company are also very proud of their training centre, and here visitors will see how apprentices receive training in their chosen craft. A full-time staff of six instructors provide practical and theoretical instruction in foundry-work, patternmaking and engineering trades.

William Mills Limited

William Mills Limited is one of the oldest-established aluminium alloy foundries in Great Britain. Its history goes back more than 50 years. It is certain that in 1898, as Williams Mills & Company, the firm was producing castings in aluminium and indeed there is a moulder still working with the company who was engaged on such work at that time.

During the following years, development must have been rapid, for in the boardroom there hangs a photograph of the company's exhibit of aluminium castings at the Automobile Exhibition at the Crystal Palace in 1903, a display which would compare not unfavourably with some seen at the Motor Show at Earls Court, both for type and variety.

The foundry was then situated in Sunderland. It was transferred to Birmingham in 1905, where it was established at Grove Street, and was well known as one of the leading producers of aluminium-alloy castings, and rendered great service in this capacity during world war one. Incidentally, it is the name of the company's founder which was so widely known at that time in connection with the Mills grenade.

Subsequently the foundry business became a subsidiary of the British Aluminium Company Limited and continued to play a very important part in developing the use of aluminium-alloy castings in very many industrial fields.

In world war two, the company was engaged in

the provision of essential armaments and in 1942, on behalf of the M.A.P., undertook the planning, erection, and operation of a foundry designed primarily for production in quantity of sand castings for such famous engines as the Merlin, Sabre, and Hercules.

This was the Friar Park Foundry, to which, after the war, all the company's activities were transferred, and 40 years' occupancy of the Grove Street premises came to an end.

Sand Foundry

The features of the plant as seen today reflect its origin. The sand foundry was laid-out to take advantage of mechanical-handling equipment, while retaining a very high degree of flexibility of working. A general view of this foundry is shown in Fig. 26. There is a row of moulding machines on the left; and completed moulds are moved, by way of the roller conveyor, into the metal melting bay on the right, ready for pouring. After pouring they are knocked out over gratings, the used sand being returned by underground conveyor belt, reconditioned, with the addition of new sand as required, and delivered by the main distribution belt to hoppers serving the moulding stations. The moulding floor is served by electric jib cranes along both sides and by a 5-ton travelling crane covering the whole area. The equipment of the main melting bay includes a 6-ton reverberatory furnace, together with a number of oil-fired tilting crucible furnaces of Morgan type, and lift-out steel pot furnaces fired by producer gas. This bay is served by overhead electric travelling crane.

Gravity-die-casting Foundry

The gravity-die foundry (Fig. 27) is situated at right-angles to the sand foundry and in the same building, but in course of time it is intended to transfer the department into a specially-designed building of its own. In the meantime, three rows of crucible maintaining furnaces are arranged lengthwise down the building, and the necessary air, gas and oil services are brought to them overhead. Where appropriate, mechanical aids in the form of electric and pneumatic hoists or hand-operated tilting and lifting gear are provided, and in the case of some of the larger dies the opening and shutting mechanism is operated by compressed air.

Pressure-die-casting Foundry

The pressure-die-casting foundry is a more recent addition which is still in process of development. It is provided with cold-chamber machines of Lester-Phoenix, Peco, Reed-Prentice, and Edgwick type, the capacity of which ranges up to 10-lb. cast weight.

The factory also contains the usual ancillary departments such as patternshop and toolroom, and there are adequate laboratory facilities for material control. These include chemical, mechanical, and metallurgical laboratories and, in addition, two X-ray sets are in constant use both for inspectional purposes and in the development and checking of foundry technique.

FIG. 26.—*Main sand-foundry bay at the Friar Park Foundry of William Mills, Limited.*

The heat-treatment department is equipped with automatically-controlled batch-type electric furnaces, and for precipitation treatment gas-fired furnaces are also available.

Qualcast, Limited

Qualcast, Limited, was originally founded in Sheffield in 1801 by the great-grandfather of the present chairman and managing director, and moved to Derby in 1849. The firm occupied three separate premises in Derby, whilst being known as the Jobson Foundry Company and the Derwent Foundry Company (1920), Limited, before changing the name to Qualcast, Limited, in 1928 at the formation of a public company, prior to moving to the existing site in Victory Road in 1929. Before the first world war, the company had concentrated on the stove and grate business, but after entering the munition field during that war they have since specialized in high-quality light repetition grey-iron castings. Due to the expansion of the business at Victory Road, new premises have been acquired in Derby for the finished-products division, and the entire Victory Road site is now devoted to foundry production.

Iron Foundries

It is now well known that in 1940 the company acquired the sole rights for Europe of the Eaton permanent-mould process, which has now developed at this site into two separate foundries producing permanent-mould castings, one having ten machines installed, and the other, a more modern plant laid down in 1952, is equipped with seven machines. These two foundries combined have a

FIG. 27.—*Part of gravity-die foundry, Friar Park Foundry (William Mills, Limited). Three rows of holding furnaces are arranged lengthwise down the shop. In the case of large dies, the opening and closing mechanism is operated by compressed air.*

capacity of over 500 tons of good castings per week. The original plant is now in process of being changed over to two hot-blast cupolas worked on alternate days, whilst the newer plant relies on two 42-in. cupolas worked alternate days by the cold-blast principle. In the latter case, mechanical cupola charging is a noteworthy feature, particularly with its economy of manpower. Here the charges are weighed in drop-bottom charging buckets on a travelling scale-car before being hoisted directly into the charging door of the cupola. All pig-irons and shop returns are delivered to the charging bucket by means of a 5-ton magnet crane, which is also used for discharging incoming supplies arriving by road and rail. These two foundries are served by an extremely efficient die-making department, which is very well equipped with modern plant.

There is also the orthodox grey-iron foundry, specializing in high-duty castings for the automobile, refrigeration and electrical industries, using conventional but highly-developed methods of moulding, core-making, etc. This foundry is served by two 56-in. dia. cupolas and one 36-in. cupola, and deals with nearly 350 tons of good castings per week of an average weight of 3 lb. This section is served by a coreshop in which the visitors will be interested to note that hand coremaking has been almost entirely eliminated.

Other Activities

Since 1935, a steel foundry has been developed on this site which is now served by a 30-cwt. Stobie direct-arc furnace with the recent addition of a 3-ton Efco direct-arc furnace of the latest design for the production of heat-resistant and abrasive-resistant castings, of which the present output is approx. 75 tons per week.

There is also a small pilot plant engaged on the shell-moulding process which the Company state is still in its experimental stages.

The layman visitor who relies on national advertising for his general knowledge will be surprised that there is no semblance of lawn-mower production at these works, which really consist of four completely self-contained foundries forming part of the thirteen works/divisions comprising the Qualcast Group.

Joseph Berry, Limited

Joseph Berry, Limited, was founded in the year 1865 essentially as a foundry for the production of general-engineering castings of a small and medium nature, its moulding, coremaking and dressing area in those days being in the order of 4,500 sq. ft.

The business was carried on by the founder and his sons, making progressive extensions until the year 1929, when it was taken over by B. & S. Massey, Limited, Manchester, for the production of castings required in the manufacture of forging and drop-forging hammers, presses and forging presses, the castings of which are playing their part in the forges of nearly every country in the world.

It is essentially a "jobbing" foundry with no specialization, making heavy and light section castings by the loose-pattern method, which are cleaned by the Hydroblast process. (See Fig. 28.)

The working area to-day is 28,000 sq. ft. and the chief products are power-hammer cylinders up to 12-ton in weight, and anvil blocks up to 30-ton in weight, heavy machine-tool beds and columns, and diesel oil-engine cylinder housings.

Melting of all metal is carried out by the orthodox cupolas of various capacities.

Ley's Malleable Castings Company, Limited, Derby Works

Ley's have been producing blackheart malleable castings for more than 75 years and now employ 2,500 workpeople at the Derby foundries. The major product is "Black Heart" malleable with a tensile strength of 24 ton per sq. in., and an elongation of 16 per cent. Pearlitic malleables are also

made under the trade name of "Lepaz," with tensile strengths up to 35 ton per sq. in.

Individual weights of the castings produced range from ¼-oz. to 150-lb. The great variety of work and production quantities result in diversity of methods of moulding and production. Many types of moulding machines are utilized and a little floor and bench moulding continues to be practised. Many of the foundry layouts of the heavier jobs are mechanized, using roller conveyors to accommodate the batch melting and being cast from crane ladles.

The majority of the castings are for the motor industry and includes the largest castings made, namely, commercial vehicle axle-cases. The lightest castings are chain links, which are produced for the firm's associated elevator and conveyor manufacturing company, the Ewart Chainbelt Company Limited (Fig. 30).

A mobile magnet crane is used for unloading pig-iron and scrap. Internal transport is largely by petrol and battery trucks incorporating the use of trailer, stillages and fork-lift trucks.

Most of the metal is melted in pulverized coal-fired reverberatory furnaces of 20 to 25 tons capacity, each operating furnace making two heats a day. The large furnaces are charged by overhead travelling cranes and are equipped with waste-heat water-tube boilers, which provide steam for space heating and for power which is generated by two 1,350 kw. turbo generators.

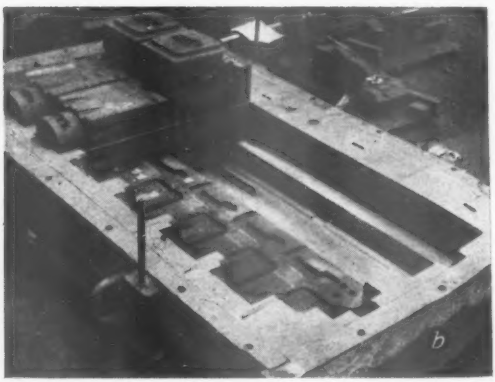
There are two central coal pulverizing and distributing plants with capacities of 400 and 250 tons of coal per week using Ruggles-Coles dryers and Hardinge ball mills. Coal is also pulverized in three "Atritor" unit mills each of 30-cwt. and one of 15-cwt. per hour capacity.

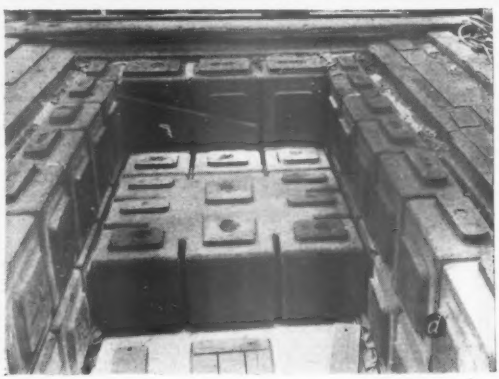
Foundry

There is a fully-mechanized foundry, producing 50 tons per week of light castings on magnetic squeeze moulding machines. The metal for this plant is duplex melted in water-cooled fore-hearth cupolas, feeding a nose-tilting electric-arc furnace of 3 tons hot metal capacity, which provides continuous metal for pouring on the pallet mould conveyor.

Apart from a continuous Smedley mill in the mechanized foundry, moulding sand is batch milled, for the most part in Simpson mixers. Some

FIG. 28.—(*a*) *General view of the main Foundry bay of Joseph Berry, Limited;* (*b*) *core assembly partly completed for a 6-cylinder diesel oil-engine housing;* (*c*) *mould for a 22-ton machine bed, completely cored and ready for the top part;* (*d*) *partly-cored mould for the machine-tool bed.*





sand mullers are in use on individual layouts. Synthetic sand is used almost exclusively and is dried in gas-fired rotary sand dryers.

The coreshops, consuming 200 tons of silica sand per week, are equipped with gas-fired continuous vertical stoves. About 100 tons per week of cores are blown on large Osborne and small Corall and Redford machines. Rollover and draw machines are used for the largest cores.

There are well-equipped wood and metal patternshops.

Annealing is largely carried out in pulverized-coal ring-main-fired bogie hearth ovens of 25 tons capacity and all annealing-oven stacks are fitted with photo-electric smoke recording and signal lamps. Packing stations are equipped with hydraulic lifting platforms, and the packing material is mechanically handled through magnetic and dust separating plant. The packed castings are loaded on to the bogies by overhead travelling cranes. There is a recent installation of two pairs of Birlec electric two-stage annealing furnaces each of 18 tons capacity operating an overall 48-hr. cycle, with controlled atmosphere and fully automatic programme control.

Cleaning plant includes numerous airless-Tumblast and table machines. Fettling is carried out on high speed Alundum stand grinders. Castings are straightened in dies on hydraulic presses of varying capacities, up to 140 tons. Inspection includes among the routine methods, jigs and gauges, hydraulic testing, pickling, magnetic and fluorescent crack detection and hardness testing.

All appropriate equipment is ventilated and dust separation and collection variously by cyclones and bag filters. There are four Sturtevant wet dust collectors in use on grindery exhausts.

In addition to the usual metallurgical and chemical laboratories, there are two routine sand testing laboratories and an air-conditioned spectrographic laboratory, where rapid analyses are made on bath tests ensuring correct metal composition before pouring (Fig. 29).

Metropolitan-Vickers Electrical Company, Limited

Metro-Vick., is nearly as old as the electrical industry; it was founded, as the British Westinghouse Electric & Manufacturing Company, in 1899. Soon afterwards, work commenced on the construction of the present "main works." The foundation stone of the main offices was laid in 1901 by the Lord Mayor of London, and by the end of 1902 production was under way.

The main factory building was 900-ft. long, 440-ft. wide and 60-ft. to the eaves, and consisted of several parallel bays under the one roof. Large as the factory was, its construction on a site of 130 acres is a tribute to the foresight of those who recognized that extensions would be necessary in the years to follow. It is equally significant that the original buildings have served and still serve efficiently, even for the larger products of to-day, without major alterations to the structure.

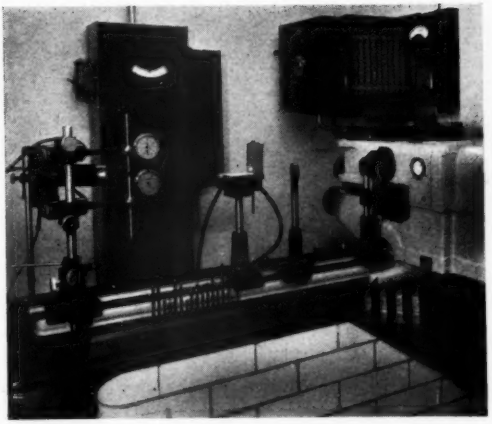


FIG. 29.—*Section of the air-conditioned spectrographic laboratory of Ley's Malleable Castings Company, Limited.*

Despite some difficulties in the early years, by 1917 the company had become established as a highly-efficient organization with a sound reputation. The year 1919 saw the change to the company's present name, by which time the company had become entirely British, and the only remaining association with the Westinghouse Company of America was for some exchange of manufacturing and research information. In 1929, Associated Electrical Industries, Limited, was formed, linking the activities of Metropolitan-Vickers, the British Thomson-Houston Company Limited, Ferguson Pailin Limited and the Edison Swan Electrical Company Limited. This association still continues, extended by the inclusion of some subsidiary firms. With its formation the technical liaison with the Westinghouse Company of Pittsburgh ceased.

From the beginning the company undertook a wide range of manufacture, including plant for electric power generation and transmission, electric traction and industrial electrification. The steady expansion in these fields, coupled with the newer activities of the company, has involved the construction of more buildings. The works has, in fact, grown beyond the limits of the original site, as several local factories built or taken over for special wartime products are now used for normal manufacture.

Such a large diversity of products, ranging from large turbo-generators (Fig. 31) to delicate instruments, has involved the manufacture of a similarly wide range of castings.

Foundries

The foundries (Fig. 32), which produce castings in both iron and non-ferrous metals, cover an area of 212,913 sq. ft., which is divided into five parallel bays. They have not been enlarged since 1920, and in general remain as originally constructed early in the century, but their range of output during the last 50 years has expanded far

FIG. 30.—*Pouring of the smaller type of slip-jacketed moulds from monorail - suspended ladles at Ley's Malleable Castings Company, Limited.*

beyond that originally intended. A comprehensive scheme of reorganization begun in 1947 led to the present standard of working conditions, which are accepted by the authorities as complying in practice with the recent Foundry Regulations.

The main bay, in which the headroom is 80 ft., contains two 50-ton and two 25-ton cranes, while the side bays are equipped with 10-ton, 5-ton and 2-ton cranes. Nine cupolas are available, and at least four of these work daily. They range in size from 30-in. to 72-in. diam. and have a total capacity of 54 tons per hour. The variety of iron castings produced reflects the wide range of the company's products, castings varying in weight from 1 oz. to over 60 tons.

At the N.W. corner of the building is the non-ferrous foundry, where the company's requirements in brass and aluminium castings are manufactured. Here is installed plant of the latest type, and die-castings are produced from pressure- and gravity-dies.

Prominent features of the foundries are the wide and well-planned gangways, and the use of concrete floors wherever possible. Fume-removal plant is installed at knockout stations and at the melting points in the non-ferrous foundry. Hydroblast is used in dressing shops, enabling castings to be

FIG. 31.—*Section of turbine-rotor assembly bay at Metropolitan-Vickers Electrical Company, Limited.*

cored without the usual dirt and dust. Efficient central heating is provided, and clothing lockers, bathing and washing facilities and a modern lavatory system are installed at convenient points.

The staff in the foundries and the adjacent patternshop is just over 1,000, and a noteworthy feature of the organization is the importance attached to the training of apprentices.

Sterling Metals, Limited

Sterling Metals, Limited, was established in Coventry 48 years ago, primarily for the manufacture of aluminium sand castings, and originally employed 20 people. Since 1907, the company has developed rapidly and to-day employs 2,500 people. By 1939 the company had outgrown the Coventry premises and embarked upon an ambitious building programme at Nuneaton, where—at the present time—still further large extensions are in progress.

The geography of the foundries is:—

COVENTRY:

Cast Iron—Specializing in the production of cylinder-block and cylinder-head castings, almost exclusively for the motor, tractor and heavy-vehicle industries.

Light-alloy Gravity-die Castings.—In aluminium and "Elektron" magnesium alloys.

NUNEATON:

Light-alloy sand and precision castings—In aluminium and "Elektron" magnesium alloys. The several foundries embody varying degrees of mechanization to suit the type of production involved.

It should be noted that the production of "Elektron" magnesium alloy castings in England was pioneered by the company—so much so that to-day Sterling Metals, Limited, are one of the largest producers in the world. The introduction of "Elektron" magnesium zirconium/rare earth/thorium alloys during the past few years has been of particular interest to the aircraft industry which now uses them extensively.

The very large amount of work undertaken for the aircraft industry, covering aero engines and airframe castings, has made necessary the installation of an extensive range of X-Ray units to fulfil the rigid inspection requirements demanded.

In like manner, most modern laboratory and inspection equipment is available to facilitate examination of castings before despatch.

Research and development work is always in progress to maintain the acknowledged high quality of the products, and the more recent introduction of plaster and shell moulding and CO_2 processes, are carefully watched and practically operated where quality, economics or advantages to consumer are to be gained thereby.

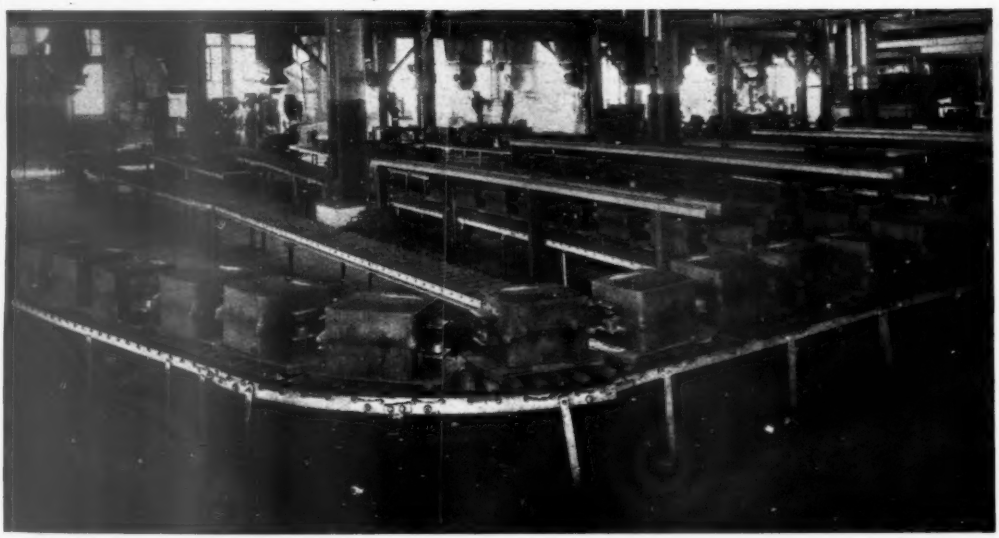
Whilst a large part of the production of the light-alloy foundries is devoted to the aircraft industry, practically every field of engineering is served, especially the motor car, tractor and heavy-vehicle industries.

During the past few years, special attention has been given to the textile industry, and considerable success achieved. It was found necessary to supply finished-machined products, and light alloys, particularly "Elektron" magnesium alloys, are used for the production of such items as:—

Driving drums for high-speed warping machines, high-speed beams, flanges, section beams, jacquard cylinders.

To ensure satisfactory service from high-speed

FIG. 32.—*Part of the Metro-Vick small foundry showing the casting on the conveyor legs from the machines and feeding moulds to the loop conveyor leading to the knock-out.*



products, dynamic balancing is essential and every drum or beam operating at high speed is dynamically balanced before despatch.

It is interesting to note that the textile products are exported all over the world. A view of the firm's patternshop is shown in Fig. 33 and the iron foundry in Fig. 34.

W. & T. Avery, Limited

W. & T. Avery Limited are reputed to be the biggest manufacturers of weighing machines in the world, and of testing machines. They now have a world-wide business and more than 10,000 employees. Manufacture was started in Digbeth, Birmingham, in 1730 and in 1854 the Atlas Foundry in Greets Green, West Bromwich was acquired. In 1895, the business had outgrown the then existing manufacturing facilities and the Soho Foundry was purchased. Additional buildings were erected from time to time until by 1945 the 25 acres at Soho were well covered. The business still continued to expand, and in 1946 an aircraft factory of some 340,000 sq. ft. at Sherburn-in-Elmet, in Yorkshire was taken over. Even these additional facilities were not enough to cope with increasing demand, so, in 1951, 122 acres of land occupied by the Ministry of Supply factory at Tame Bridge was purchased.

Tame Bridge Foundry

Tame Bridge foundry which the IBF parties will visit is claimed to contain the most efficient and up-to-date equipment the world has to offer. Some of it has been created by Avery's own foundry engineers, some has come from the United States, but most has been built in this country. One of the foremost considerations in the planning of the Tame Bridge Works has been the high standard of working conditions. With the suppression of dust and fumes, the provision of clean air, good light and efficient heating, as well as the improvements in the founding methods, the conditions at Tame Bridge surpass those of a modern engineering shop. Adjoining is a separate amenities block, and here foundrymen can put their working clothes into a locker, have a shower, and take their clean travelling clothes from a heated locker. The building also contains a canteen, first-aid station, and other amenities. Production at Tame Bridge will cover all the heavy castings made by the firm. The correct preparation of the various sand mixtures is given great importance, and the elaborate sand plant takes care of these processes, largely mechanically, and is integrated in design with the sand store to reduce handling to a minimum (Fig. 37).

Furnaces and Moulding

One of the major improvements introduced at Tame Bridge is the continuous-flow cupola plant. Two furnaces have been installed, each in use on alternate days, melting at the rate of 9 tons per hour. All the ingredients of the "melt" pass through a weigh-hopper into a cylindrical drop-bottom bucket. This is carried to the furnace by a charger of unusual design. After the metal is melted, it is fed into an oil-fired receiver, from which it can be drawn-off as required. The cupolas are equipped with modern type dust-arresters which use 142 gallons of water per min.

FIG. 33.—*Section of the patternshop.* (*Sterling Metals, Limited.*)

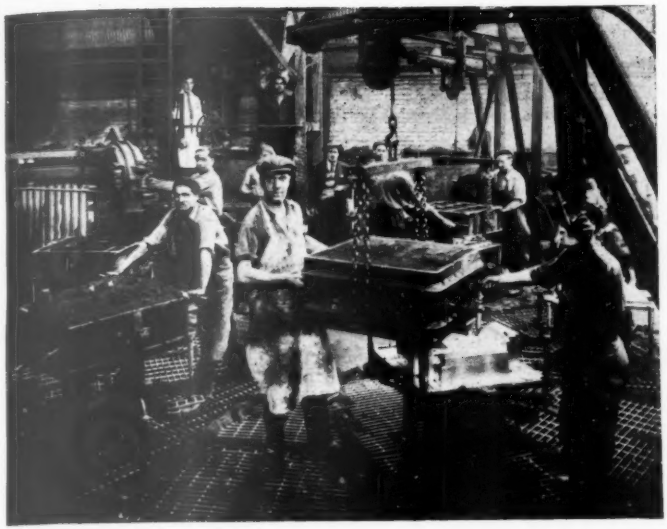


FIG. 34.—*Section of iron foundry at Sterling Metals, Limited.*

For moulding a motive Speedslinger has been introduced into the large and medium sections. This machine, under the control of one man, in a few minutes performs the equivalent of many hours of hand-ramming, and is one of three at present installed in Great Britain. It carries its own sand supply in detachable hoppers, each holding 15 tons, and delivers the sand to moulding boxes at the rate of 2,000 lb. per min. (Fig. 39). Working in conjunction with the Speedslinger is the compactly-designed heavy sand plant which recovers used sand and prepares it for further use. When the casting has been made and cooled, the sand is shaken free over what may be the largest shakeout in Europe.

Pattern-flow System

A pattern-flow system has been introduced for the production of medium-size castings in quantity. It is an arrangement which permits the patterns, mounted on plates or boards, to be fed into the system and move in succession along roller tracks. They are rammed-up in the moulding boxes by a Sandslinger delivering about 800 lb. of sand per min. This method has only recently been applied to castings of this size, and is the outcome of an experimental and highly-successful installation made at Soho Foundry about five years' ago. The pattern-flow installation has its own shakeout and sand-reconditioning plant.

Bradley & Foster, Limited

The Darlaston iron works of Bradley & Foster Limited, are carrying on a Staffordshire iron-making tradition of about 140 years and is one of the largest suppliers of refined iron in the country.

Production of Refined Iron

The production of refined pig-iron is divided between three separate plants, each plant being specially suited to the type of iron produced. One of the plants is a modern mechanized unit built in 1943, producing machine-cast refined iron. The furnace is one of the largest of its type in the country and is fully water-cooled, utilizing water-cooled internal segments and tuyeres. Raw materials are charged into the furnace in drop-bottom buckets shunted on flats cars to the charging station by a diesel locomotive. Overhead cranes and electromagnets are used to handle ferrous materials in the charging bays and in the refined pig-iron bay.

High-carbon low-sulphur sand-cast basic refined irons are produced on another plant where a basic-lined cupola has been in service since 1951. Refined irons of this type are in demand for the production of nodular cast-iron and a considerable tonnage is exported each year for this purpose. Consistent properties are ensured by tapping into oil-fired, hot-metal receivers.

The remaining refined-iron plant has been in operation since 1922, and consists of two acid-lined furnaces. Raw materials for the furnace are hand charged into drop bottom skips on a self-propelled

FIG. 35.—*A view showing an operator at work with the Hilger large quartz spectrograph in the spectrographic laboratories of Bradley & Foster, Limited.*

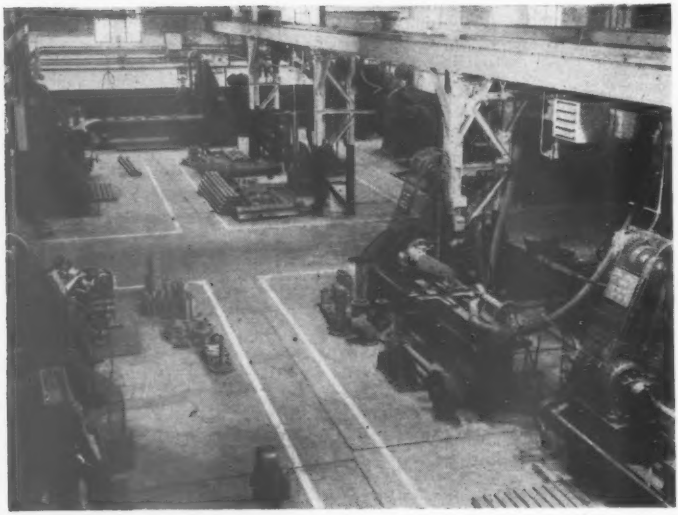


FIG. 36.—*A general view of one bay of the silicon iron machine shop at Bradley & Foster, Limited.*

railway scale car which transports them to the charging station. The overhead beam supporting the Heywood charging machine is movable and can be swivelled to serve either of the two furnaces. Molten iron is tapped into 10 ton capacity hot-metal receivers which can be moved along the head of the pig beds on rails. A special mechanical stirring device is used when required to obtain homogeneous casts of special iron. Refined malleable pig-iron and high-alloy refined irons are produced on this plant.

Alloy Iron Foundry

The firm has specialized for many years in the production of many types of alloy iron castings. The types of alloys normally cast include high-silicon alloys, hard martensitic white irons and high-carbon chromium alloys, all of which pose special casting problems. Wear-resisting, heat-resisting and corrosion-resisting alloy casts are made in a modern foundry built at the beginning of the last war. Melting facilities consist of a 3,000-lb. Birlec Lectromelt arc furnace, two Detroit 8-cwt. rocking-arc furnaces and a two ton Stein Atkinson oil-fired rotary furnace. The foundry is equipped with two large, coal-fired, annealing stoves which are used to stress-relieve silicon-iron castings. A considerable tonnage of castings is made in B.F. 954, an alloy with outstanding wear-resisting properties which has found many applications in plants used for the crushing and grinding of hard abrasive materials. Highly-alloyed ingots of special alloys are also cast in this foundry to customers' specifications.

Machine Shop

The foundry is served by a modern machine shop equipped with special equipment to machine hard alloy castings. Both B.F. 954 and the high silicon iron alloys are too hard to be machined by normal methods and special techniques and machines have been devised for the purpose. Most of these machines utilize a high-speed grinding wheel in place of a cutting tool (Fig. 36).

Heat-treatment Department

The heat-treatment department is one of the oldest departments in the firm and is comparatively small in relation to modern continuous plants elsewhere. A wide variety of work is undertaken, usually in small batches and of such a shape and size that special precautions are necessary to prevent distortion and other defects. The plant consists of a conventional batch-type gas-fired furnace and all types of heat treatment can be handled. The nitrogen hardening shop is equipped with two batch-type electric furnaces of the usual type for nitrogen hardening.

An interesting and somewhat unusual manufacturing process, carried out in a separate works, is the manufacture of metallic abrasives, used in shot blasting, peening and many other applications. A wide range of abrasives are produced ranging from hard chilled white-iron shot and grit to tough abrasives such as Malleabrasives and hard-drawn-steel pellets. Besides supplying a large proportion of the metallic abrasives consumed in this country a considerable tonnage of abrasives are exported to all parts of the world.

Technical Control

A comprehensive system of technical control is centred on the works laboratories which are equipped to carry out both chemical and spectrographic analysis. A Hilger large quartz spectrograph (Fig. 35) is used for ferrous and non-ferrous analysis of incoming materials and as a rapid check on samples from the works. Spectrographic analysis has proved particularly useful in controlling the residual element content of basic-refined irons, in demand for the production of magnesium treated spheroidal graphite cast iron. The chemical laboratories handle a fairly large volume of work since each individual cast of refined iron is analysed for the common elements and the alloy content of every melt in the foundries is checked. A modern building is under construction which will eventually house the whole of the works technical staff and facilities. Provision has been made for chemical, spectrographic and research laboratories and up-to-date physical-testing equipment is to be installed. A small experimental foundry is being equipped adjacent to the laboratories to serve as a pilot plant.

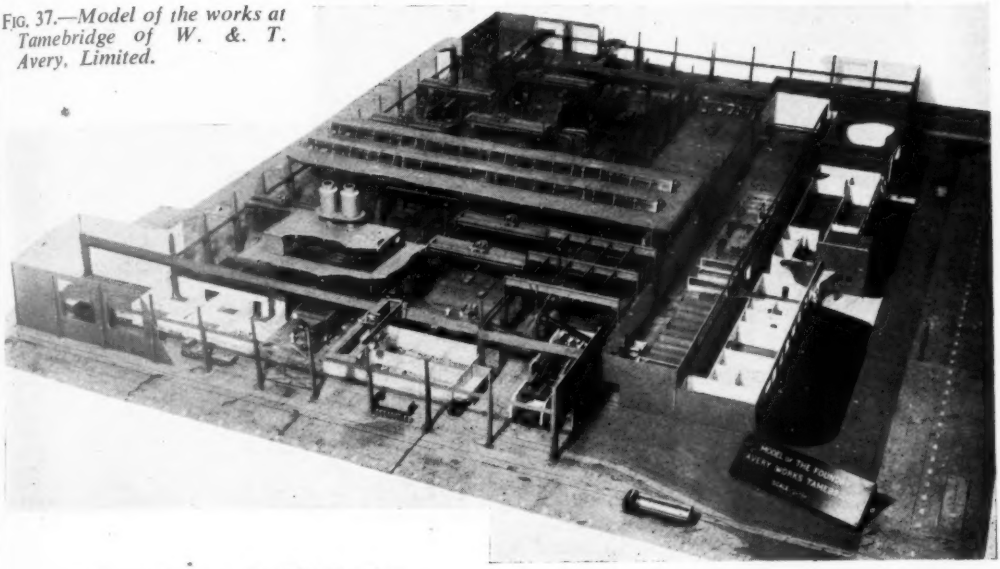


FIG. 37.—*Model of the works at Tamebridge of W. & T. Avery, Limited.*

National Gas & Oil Engine Company, Limited

The company was founded in 1889 by Mr. H. N. Bickerton for the purpose of manufacturing horizontal gas engines, in premises which had previously been occupied by Isaac Watt Boulton for building locomotives.

By 1910, the works had been considerably extended and vertical tandem gas engines were being manufactured up to 12 cylinders, with a bore of 26-in. and a stroke of 24-in., operating on town's gas, producer, blast-furnace or coke-oven gas, etc., and developing up to 1,500 b.h.p. at 200 r.p.m.

Following the introduction of the oil engine the company developed compression ignition types, firstly with horizontal engines and later with vertical engines up to 17 in. bore by 21 in. stroke, these latter have now been developed to give outputs up to 2,000 b.h.p. when using turbo-pressure chargers, which were introduced into standard production in 1936 (Fig. 40).

In 1938 the first dual-fuel engines were built and also a high-compression gas engine, and these were followed by the alternative fuel engine which operates either as an oil engine, a gas engine with oil ignition, or as a gas engine with spark ignition. Many gas and dual-fuel supercharged engines are in service, the company being the only maker of such engines in this country at the present time and the company also pioneered the development of engines using methane gas, generated from sewage sludge, as fuel.

At the present time, vertical engines are manufactured ranging in power from 62 to 2,000 b.h.p. and horizontal engines from 3 to 90 b.h.p. Marine auxiliary and propulsion units are made to develop from 77 to 1,880 s.h.p. at speeds of from 1,000 to 333 r.p.m. and installations up to 7,500 s.h.p. can be made by four eight-cylinder pressure-charged engines geared in pairs for twin-screw vessels. A recent installation, of which a working model is on view at the works, consists of propulsion and auxiliary machinery in the geared diesel whale-catcher "Setter IX," the first British vessel of its type. The main engines are two National "B4AUM6" type, each capable of developing 1,750 b.h.p., the drive being to a twin-input single-output gearbox, through electric slip couplings. There are four auxiliary units—three of 150 b.h.p. and one 72 b.h.p. Land installations cover a wide field of applications for power generation, pumping sets, irrigation schemes, etc., which have helped in the opening up of undeveloped areas of the world.

The company maintains a world-wide sales organization, in conjunction with its associates, covered by associate selling companies or appointed agents who in many cases have a representative seconded to their staff.

Foundry

The first castings made in the works were produced in 1898 and to-day out of a total of about 2,000 people employed at the factory, 230 are engaged in the foundry, which now comprises four bays each 400 ft. in length and having a total width of 200 ft., wherein some 5,000 tons of castings are produced annually. Individual castings range in weight from a few ounces up to 15 tons and are made in green sand, dry sand, or loam moulds. Castings are made in plain or alloy irons having tensile strengths from 12 to 30 tons per sq. in., combined with properties of wear, shock and heat resistance according to service requirements and are produced under conditions of close metallurgical

control which such a wide range of types demands. The bulk of the metal is melted in cupola furnaces but for the higher strength grades a 5-ton capacity rotary furnace, fired by pulverized anthracite, is used whilst for smaller quantities of special high strength castings a battery of three oil-fired crucible furnaces is used, each having a capacity of 600 lb. The rotary furnace is also employed to make special refined and alloy pig-irons for use in the cupola furnaces and to melt cast-iron borings for conversion into pig-iron.

The main machine-moulding section of the foundry consists of a battery of six moulding machines of the jolt/roll-over/pattern-draw type having capacities from 1,500 to 4,000 lb., operated by compressed air. Sand is delivered to overhead storage-hoppers from a storage and conditioning plant at one end of the line and boxes are "knocked out" on a vibratory machine over a pit feeding the storage hopper. The moulds are skin dried by passing through gas-fired tunnel-type stoves, and the plant constitutes a self-contained unit dealing with a large range of medium-size castings.

Special moulding and core-making techniques and tackle have been developed in many cases for the economic production of standard castings required in quantity. Large engine columns and bedplates are made in specially constructed pits in the floor, and the moulds are skin dried by rings of gas jets. Each bay is served by mains carrying town's gas boosted to a pressure of 5 lb. per sq. in., for use in skin-drying moulds "*in situ*," hand torches, ladle drying and heating, etc.; compressed-air mains, in addition to serving the machine-moulding sections and fettling shop, are used to supply air to all areas for cleaning out moulds during coring up. Jib cranes are largely employed to avoid "bottlenecks" due to demands on the overhead-travelling cranes.

Fettling Shop

A feature of the fettling shop is the use of a

FIG. 38.—*Hydroblast cleaning of a large cylinder-block casting at National Gas & Oil Engine Company, Limited.*

"Hydroblast" plant (one of the first to be installed in an iron foundry in this country) for the removal of cores from the larger castings (Fig. 38). This has in large measure elmininated the dust problem in the fettling of large castings, has enabled the work to be done in a fraction of the time previously taken, and provides a washed and graded sand which is put through a rotary gas-fired drier and returned to the coreshop for making oil-sand cores.

During recent years, a re-tooling programme

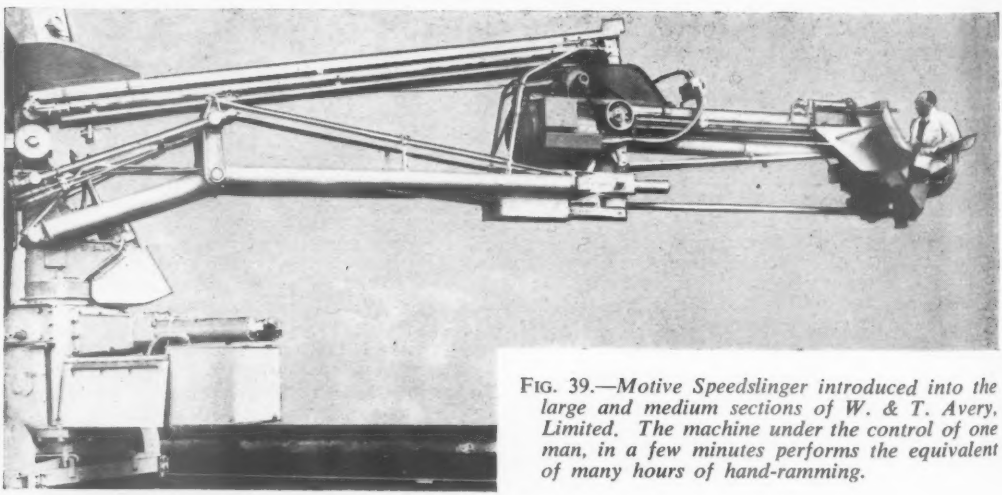


FIG. 39.—*Motive Speedslinger introduced into the large and medium sections of W. & T. Avery, Limited. The machine under the control of one man, in a few minutes performs the equivalent of many hours of hand-ramming.*

throughout the works has involved an expenditure of about £600,000 for new machines.

In 1952 the policy of the company, following the trend of world requirements, was to concentrate on the manufacture of vertical engines, and considerable re-organization of the machine shops and fitting bays was necessary in order to establish a flow-line principle.

Mather & Platt, Limited, Manchester

Mather & Platt was founded in the Salford area about 150 years ago and moved to its present site in Newton Heath about the turn of the century. It manufactures a wide variety of products, including centrifugal pumps, electric motors and generators, textile-finishing machinery, food-canning machinery, automatic fire-protection equipment, fire-resisting doors and steel-rolling shutters.

General

Erection of the present iron foundry began in 1936 and the first metal was cast in 1938. The foundry is concerned almost entirely with jobbing production, turning out at the present time about 70 tons of grey-iron castings per week, which may vary in weight from a few ounces to about 20 tons. It employs approximately 180 workpeople.

The foundry is divided into three main bays, "A," "B," and "C," each 50 ft. wide and 450 ft. long. Between bays "A" and "B" a bay 10 ft. wide contains one 3½-ton and two 8-ton cupolas and a women's coreshop. "A" and "B" bays are lit by mercury vapour lamps, while "C" bay has fluorescent lighting, providing an even illumination of about 12 lumens per sq. ft. throughout at floor level (Fig. 42).

With the exception of floor-moulding space, the foundry is concrete floored.

To handle castings for the larger pumps and textile bowls, there are six pits of depths between 4 ft. and 12 ft. and up to 12 ft. square.

Lifting Tackle

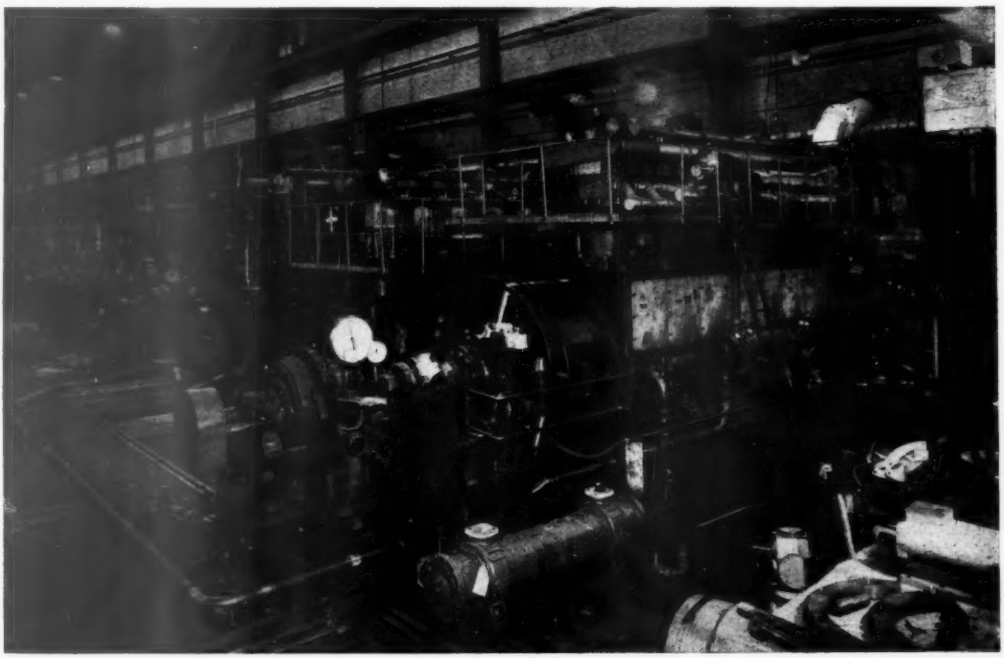
One 30-ton, two 20-ton and six 10-ton cranes operate in the main bays with two additional low-level cranes to serve the moulding machines. A number of 1-ton jibs are situated about the foundry and there are three 2-ton jibs over the larger pits for coring-up and pattern-drawing.

A monorail telpher is employed for cupola-charging. An electromagnet handles the scrap, part of which is broken up at the rear of the foundry, using a scotch derrick and tup. A grab is employed for handling limestone and coke, and for digging-out sand from floor moulds.

Sand Handling

Two sand-handling and processing plants are in operation. An Augusts' plant provides facing-sand and, in addition, backing-sand for feeding the large

FIG. 40.—*Final assembly/test-bay for large vertical engines at National Gas & Oil Engine Company, Limited.*



boxes and the Sandslinger, which has a sand capacity of approximately 4 cub. ft. per min., and a working radius of 17½ ft. (Fig. 41).

A Morris plant feeds backing-sand to the moulding machines. Reconditioned sand is conveyed from the automatic shake-out and passes through a magnetic separator, a disintegrator, and aerator and a water spray. After being reconditioned it passes through another magnetic separator before being fed to individual sand hoppers by overhead belt. Smooth operation of the hoppers is ensured by vibrators, which operate only when the hopper mouths are open and sand is actually being delivered.

The machine-moulding section contains 13 roll-over jolt-squeeze machines. Moulding boxes from 14 in. up to 4 ft. square are used on the moulding machines. Elsewhere rectangular floor moulding boxes, up to 15 ft. in length, are employed.

Large cores up to 3 tons in weight are made by men core-makers at the top end of the main shop, where there are seven coke-fired stoves 12 ft. high and 26 ft. deep and of varying widths. Smaller cores are made by women in the air-conditioned coreshop in the narrow bay, where they are dried in a continuous core-stove.

Dressing

A 3-ton mechanical vibratory knock-out, with down-draught extraction, deals with the output of the machine plant in "B" bay. Larger boxes are knocked out in "C" bay into a double 3-ton knock-out with side extraction.

There are two shot-blasting cabinets in the dressing shop, each with a capacity of about 1,700 cub. ft., employing air at 100 lb. per sq. in. A 30-cwt. capacity Wheelabrator takes the smaller castings, and both pneumatic and hand chisels are used.

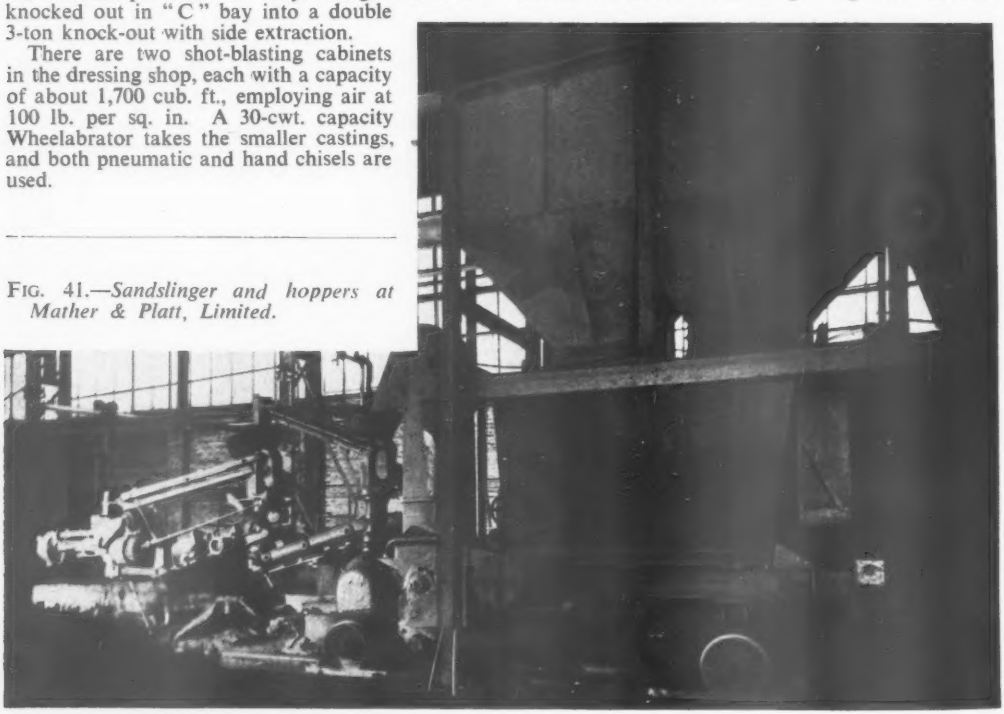


FIG. 41.—*Sandslinger and hoppers at Mather & Platt, Limited.*

Storage

Situated at the rear of the foundry and connected to it by rail is a yard in which the larger moulding boxes are kept until required and where bigger castings are stored until the machine shop calls for them. Running the length of this yard (more than 400 ft.) is a 24-ft. gantry of 40-ft. span with a 5-ton electric overhead crane.

All patterns used in the foundry are made in the patternshop in the same works, and sheds for pattern storage are situated immediately alongside the foundry.

An adjacent building contains showers, wash places, and a canteen for the foundry employees.

Park Works foundry is typical of the better class of modern jobbing foundry, well lit and airy, and producing a wide range of both simple and complex castings.

Lloyds (Burton), Limited

Lloyds (Burton), Limited, took over premises built during the 1939-45 war for the production of armament castings. Lloyds first used this purely as a mechanized grey-iron foundry, but since then increasing emphasis has been given to the development of "Lloyds' Ductile Iron"—spheroidal-graphite iron—for the production of which the firm is one of the original British licensees and pioneers of commercial-scale manufacture. Additionally, the Burton works is now making manganese-steel and

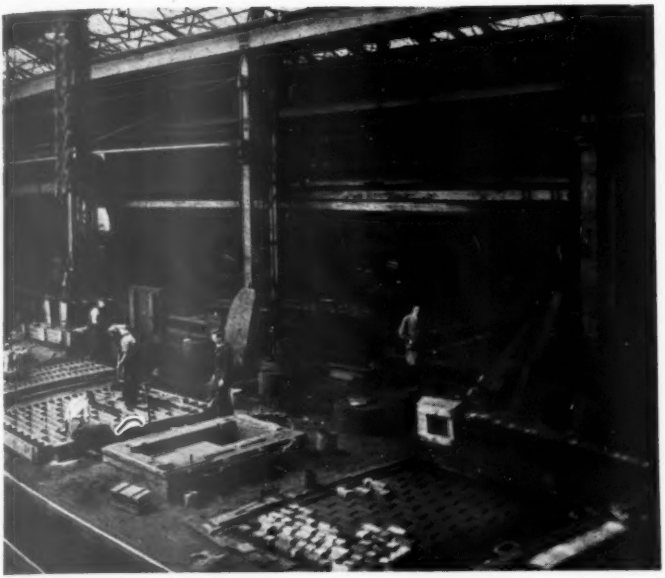


FIG. 42.—*View of floor moulding in "C" bay.* (*Mather & Platt, Limited.*)

carbon and low-alloy steel castings. For this purpose, the original works has been considerably enlarged by the addition of new bays and much modern equipment.

Special Features

Features of special interest for visitors at Lloyds' Burton foundry include the mechanization of core-sand handling, where raw sand is untouched from the time of arrival until it reaches the coremakers' benches, properly dried and mixed with agglutinants. A novelty here is the use of a blower to elevate the hot, dry sand through 40 ft. to a storage hopper, cooling it *en route*.

An item of plant which has only just commenced operation is a Russ Elektroofen, 10,000-lb. capacity, low-frequency induction melting furnace. This employs a two-core system and has a heating chamber of oval horizontal-section.

Yet a third unusual piece of apparatus is a special pressure ladle for the addition of metallic magnesium to iron in the making of higher-quality Ductile Iron. It is the SKB. Druckpfanne ladle, with a capacity of about ½ to 1 ton, which is sealed by a tightly-fitting lid after charging with molten metal. A steel tube containing the metallic magnesium is then lowered through the lid into the molten bath, the violence of the reaction—when the iron penetrates the steel tube—being contained within the pressure vessel (see Fig. 45).

Concluding the mention, special item of interest is the plant for shell moulding and shell coremaking. In this section, F.E.-Sutter (Fig. 44), Polygram and domestic-made machines are in use, producing from a variety of patternplates and coreboxes.

Normal Practice

Metal melting at Burton is normally by continuous-tapping cupolas (two, 6 tons per hr.) for iron and two 2½-ton top-charged Birlec electric-arc furnaces for steel, or duplexing if required. A heated 3½-ton receiver provides storage capacity for cupola iron. Moulding equipment includes a Sandrammer (No. 5 Senior model) and 1,500-lb. Pneulec "Herman" machines as well as Coleman-Wallwork pin-lift and other smaller jolt-squeeze-pin-lift models. The tandem sand plants each employ three No. 3 Augusts/Simpson mixers for a capacity of 20 tons of sand per hr. each. In the coreshop are large Osborn coreblowers operated by three-girl teams. Ancillary plant includes large drying ovens (two new ones of a "pusher" type), four vertical continuous core stoves and a continuous pendulum-conveyor-type Wheelabrator plant for cleaning castings as well as a Spencer & Halstead three-impeller rotary-table machine. Amenities are well looked after and an extensive programme of extensions and re-equipment is currently in hand. The works occupies a total of 22 acres, and employs about 650 operators.

F. H. Lloyd & Company, Limited

The steel foundry of F. H. Lloyd & Company, Limited, is situated at Wednesbury, Staffs. Claimed to be the largest in the country, it produces over 500 tons of steel castings each week, a large proportion being machined, and employs about 1,600 workers. The main foundry departments are: Heavy and light sections (including their separate melting plant and with a flow through to respective heavy and light fettling shops); a heat-treatment department; sand-plant; inspection and despatch sections.

Foundries

The heavy foundry consists of three bays, two of which are mainly devoted to jobbing work, while in the third heavy machine moulding is carried on. In the jobbing section there is a motive type Speedslinger for ramming sand, the first to be employed in Great Britain. This has a 26-in. dia. impeller-head which can sling sand into a moulding box at the rate of one ton per min. There is also a smaller model of the Sandslinger with a 22-in. dia. head, capable of ramming 8 cwt. of sand per min.

The light section of the foundry is more completely mechanized, and moulds are made on high-production machines after which they are cored, closed and stored on roller-conveyor banks for pouring in the requisite grade of steel. A recent

change has been to re-equip the whole of this section with new heavy-duty moulding boxes, fitted with stub-pins and bushes: This has conferred an even better standard of dimensional accuracy on the castings. A jobbing bay in the section, equipped with 5-ton capacity overhead cranes, produces box-moulded castings in quantities of up to, say, 20-off in individual weights up to 1 ton.

Other Departments

Sand Plant

An excellent skin finish is conferred on the castings in both heavy and light sections, by the use of two sand systems—facing and backing—for all jobs. The heavy foundry is provided with three No. 3 Augusts/Simpson intensive mixers, two for facing and one for backing sand. A model-30 Speedmullor supplies oil-bonded sand for lighter cores, but heavy cores are made in the same sand mix as the heaviest dry-sand moulds. The light section has a No. 3 mixer for facing sands, and here again a Speedmullor is used to provide core-sand.

Melting

All the melting is by Birlec "Lectromelt" electric-arc furnaces, of the now almost standardized three-electrode, swing-aside-roof type. Heavy-load transformer capacity for the furnace size is a measure adopted to give rapid melting and more flexible temperature control. The heavy foundry employs two, 12-ton capacity, basic-lined furnaces and one of 3½-tons. The light section has two acid-lined furnaces of 3½ and 2½ tons capacity.

Fettling

The fettling of castings is given high priority in process control at Lloyd's. All the usual methods of cutting-off runners and risers are used, but Lloyd's were the first firm to apply the new process of iron-power injection in to the oxy-acetylene-flame in "powder washing," by which means pockets or encrustrations of heavily-burnt-on sand can be cleanly fluxed off the surface of a casting (Fig. 43). Another plant used first in this country at Lloyd's is the Hydroblast which delivers a controlled jet of sand and water, at 2,000 lb. per sq. in. pressure to remove spent cores and sand from castings. Other important equipment in the heavy section is a shot-blast room and a Wheelabrator impeller-type abrasive cleaning plant employing an 8-ft. dia. rotary table on to which the castings are loaded. In course of erection is another and larger plant of this type using a 15-ft. dia. table and five impeller wheels to project the abrasive on to the castings—this will be the largest employed in the United Kingdom for this purpose. The light fettling shop also is in process of modernization and re-equipment. It also deals with much of the work produced from the moulding machines of the heavy section. Main items of plant here include a 60 by 90-in. Tumblast abrasive cleaning machine (the largest of its type in the country) and a 6-ft. dia. twin turntable Wheelabrator unit (Fig. 46).

Heat-treatment

Facilities for heat-treatment at Lloyd's are comprehensive and include hardening and tempering

FIG. 43.—*Powder-washing—a new process applied to remove burnt-on sand at F. H. Lloyd & Company, Limited.*

plant for large and small castings and even localized hardening treatment. Thus, there are four Birlec electric-resistance-type heat-treatment furnaces which are capable of giving excellent temperature and cycle control.

For larger castings there are four gas-fired bogie-type furnaces, all fully equipped with automatic control gear, temperature uniformity being particularly studied. There is a high degree of liaison between the independent inspection department at Lloyd's and the processing departments that makes an important contribution to dependability and high quality.

Machine Shops

The same tenets for securing high-quality products are carried through from the foundries into the machine-shops. In fact it is the lessons learned in machining their own castings that prove so valuable in Lloyd's methods of scrap elimination. A vast majority of the castings produced are in some way machined on Lloyd's own premises, though it may only be proof machining and this part of their work is increasing. Many of the castings are finished machined to the most exacting specifications and tolerances. Recent acquisitions in the machine-shop are a number of extra vertical and horizontal borers; particularly applicable to larger

FIG. 44.—*F. E.-Sutter machine at Lloyds (Burton), Limited, for the automatic production of shell moulds. Some of the moulds are shown in the foreground, one with its complement of shell cores.*

castings is a new floor-type Skoda machine—the first of its type in this country—having a 6¼-in. spindle, column travel 14-ft. 9-in. floor plate 17 by 14-ft. and 8-ft. 10-in. high.

Jarrow Metal Industries, Limited

In the early thirties, Jarrow had the unenviable distinction of being probably the worst of the distressed areas. Eighty per cent. of the male population were unemployed, mainly through the closing down of Palmer's shipbuilding yard under a national scheme for the elimination of uneconomical yards. In the depressed state of the shipbuilding industry at that time, this yard was considered redundant.

Moved by the deplorable situation in the town, Sir John Jarvis mobilized into action the humanitarian feelings of the county of Surrey, of which he was Lord Lieutenant. This first took the direction of supplying food, clothing and other necessities to the inhabitants. Sir John recognized, however, that this was only a palliative, and that work for the workless was the only remedy to restore life and vigour to the town.

A little was done by employing a number of men on the construction of a new park, also in supplying paint and paper to enable people to renovate their homes and infuse some spirit into minds deadened by many months of unemployment.

Shipbreaking was turned to as an absorbant of labour. The Olympic was bought by the Surrey Fund, and later the Berengaria was purchased by Sir John Jarvis for breaking up at a site in Palmer's old shipyard. There is no doubt that he could have sold the vessel again at a handsome profit, but it says much for his altruism that at no time did he allow thoughts of commercial gain swing him from his resolve to establish some sort of return to general prosperity in the area.

Sir John soon backed up his faith in the men of Jarrow with an even greater gesture. He resolved to establish a company of steelfounders utilizing the old boiler shop of Palmer's in Western Road, Jarrow. The funds were provided partly by the Treasury and partly by Sir John himself, and the new company was incorporated on October 4, 1937, as Jarrow Metal Industries Limited. The works were equipped with modern melting, heat-treatment and ancillary plant, enabling them to supply billets, alloy steel castings, etc., up to weights of about 30 tons.

When war broke out in 1939, the high output from the works at Jarrow was a great advantage, a large proportion of the metal being used for the manufacture of bombs, while steel castings for ship construction were also turned out, including turbine castings, propellers, anchors, valves, deck fittings, etc.

To cope with the Jarrow output of bomb casings, additional machinery capacity was imperative, and a new factory—Bede Well Works—was built at

FIG. 45.—*Pressure ladle at Lloyds (Burton), Limited, for the addition of metallic magnesium when making "Ductile Iron."*

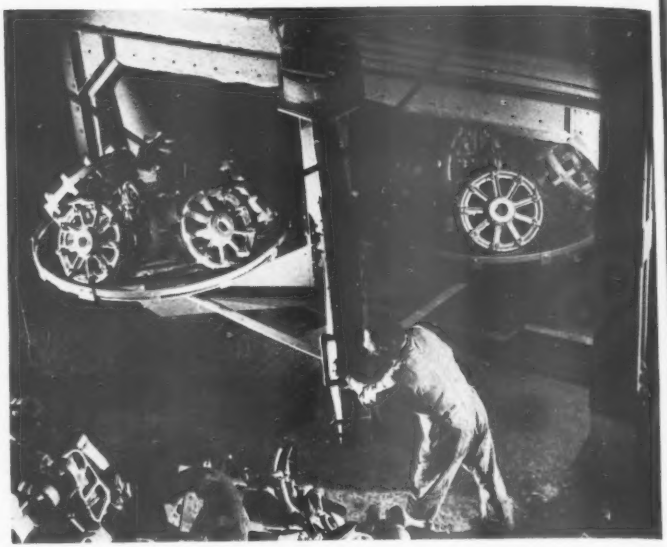


FIG. 46.—*Double swing table Wheelabrator plant for cleaning steel castings at Lloyd's Wednesbury foundry.*

Hebburn-on-Tyne on the instruction of the Ministry of Aircraft Production. The installation of all the necessary hydraulic presses, furnaces, heat-treatment and machinery for the finished production of bombs was completed in record time, and work was in full swing there by the beginning of 1941, and deliveries were going forward to the Government stores and filling factories.

Deliveries of bombs from the factories at Jarrow and Hebburn during the years 1939-45 were as follow:—

112,766	S.A.P.	500 lb.
43,140	M.E.	500 lb.
35,042	M.E.	1,000 lb.

Following the end of the war, the works at Jarrow returned once more to peace-time production of castings, and a programme of expansion and improvement was embarked upon (see Figs. 47 to 49).

Equipment

Melting equipment includes 3 basic electric-arc furnaces, one of which has a capacity of 15 tons, while the others are of 8 tons capacity.

Approximately 350 to 400 tons of molten steel are produced each week, which is divided among the various products, namely cast-steel rolls, steel castings and ingots.

Production is to almost any British Standard composition, including carbon steel, creep-resisting steel, pearlitic and austenitic manganese steel, 13 per cent. chromium and 18:8 stainless steel and high chrome/nickel heat-resisting steel.

Cast-steel rolls of all types are produced up to 45 tons cast weight, including Pilger rolls up to 10 tons cast weight.

Steel castings are made from a few pounds up to 35 tons finished-dressed weight for the marine and heavy engineering industries and include such types as propellers, anchors, turbine and valve castings, frames, cylinders, crossheads, rams, etc., for large press construction.

Ingots are supplied in various sizes up to 15 tons in weight to almost any British Standard specification.

The foundry is equipped with modern sand mills, Sandslingers and moulding machines and with a battery of up-to-date heat-treatment stoves, pyrometrically controlled and with capacities of up to 25 ft. long, 8 ft. 6 in. wide and 6 ft. high.

The cleaning of castings is effected by the use of Hydroblast plant, which has a gun room 22 ft. by 18 ft. and a metallic shot-blast plant with a chamber capacity of 15 ft. long, 12 ft. wide and 7 ft. 6 in. high, as well as the latest types of chipping hammers, grinders, Linde and air/carbon/arc burners.

Within the last six months, a pickling plant has been installed, which has a bath dimension of 12 ft. long, 8 ft. wide and 6 ft. deep and uses sulphuric acid at a temperature of 60 deg. C.

The laboratories are well equipped with modern equipment for rapid and accurate chemical analysis and for the determination of the physical properties of metallic materials.

The metallograph department has recently installed a modern microscope which enables photomicrographs at high power to be obtained under dark-field and polarized-light conditions.

The inspection department is equipped with all forms of non-destructive testing methods, including gamma radiography using a powerful isotope, two kinds of electro-magnetic crack detection, and ultrasonic crack-detecting apparatus.

There are at present about 450 workers on the payroll, with the addition of about 80 staff.

Brightside Foundry & Engineering Company, Limited

The works of the Brightside Foundry & Engineering Company, Limited, to be visited comprise foundries and engineering shops at Ecclesfield, situated about five miles north of Sheffield, and occupy a total area of 17 acres. At Ecclesfield is also the head office of the "Brightside" Group.

Visitors will see the manufacture of ingot moulds (Fig. 50) for the steel industry, mainly for the alloy-steel industry for which Sheffield is famous. These moulds range in weight from 2 cwts. to 60 tons, being made in three departments. Forging moulds are hand-rammed entirely and "rolling" sizes

FIG. 47.—*Tapping 15-ton Tagliaferri electric furnace (direct arc) at Jarrow Metal Industries, Limited.*

"jolted." It is of interest to note that moulds made by this latter method of ramming are primarily made from metal patterns leaving their own core. A wide variety of types such as square, octagonal, duodecagon and rectangular of varying lengths are constantly in production. The output of moulds made on this mechanized plant is about 10,000 tons per annum. The capacity of the jolter machines is 6 tons, therefore different methods are employed for heavier moulds. In this case the core only is jolted and the outside rammed by a 10-ton motive Sandslinger. Grey-iron general-engineering castings up to a weight of 50 tons are also produced in the heavy bay.

Visitors will also see the dressing shops to which all moulds up to 10 tons are conveyed in wagons to be cleaned of sand and dressed for despatch. Adjoining this department is the patternshop where wood patterns for the engineering and mould industry will be seen in various stages of production.

A visit will also be made to the welfare block where all foundry workers are provided with the opportunity to change their clothes and have a bath, a much-appreciated arrangement.

The tour will conclude with a visit to the engineering shops where visitors will see rolling-mill plant in various stages of production and assembly.

The company was founded in the year 1864 and has three more works in addition to the one to be visited. Two are situated in Sheffield and one at Oldham.

The Newhall works specializes in large ingot moulds and stamp block up to 150 tons in weight, various types of rolls for the steel and non-ferrous industry and the engineering industry, and large rams for hydraulic presses.

Moorwoods Limited produce, primarily, grey-iron castings up to 56-lb. in weight on a mechanized plant, the annual output being over 3,000 tons.

Buckley & Taylor Limited, the subsidiary company in Oldham, produce castings in grey iron up to 20 tons in weight and have engineering shops producing rolling-mill plant, including heavy flywheel sets, and distilling machinery.

The company is among the largest heating and ventilating engineers in the country, having established branches in ten of the principal cities of Great Britain.

The "Brightside" Group employs over 2,650.

English Steel Castings Corporation, Limited

The Grimethorpe steel foundry of English Steel Castings Corporation, Limited at Sheffield, which delegates from the International Foundry Congress will be visitng on Friday, July 1, 1955, ranks as one of the largest and most modern in Great Britain, producing steel castings of all types and sizes, ranging from a few ounces up to the largest ever made in the British Commonwealth, which weighed 185 tons.

As a newly-formed wholly-owned subsidiary of English Steel Corporation, Limited, which is also the Commonwealth's biggest producer of special alloy steels and forgings, and a large-scale manufacturer of drop forgings, springs and heavy mild-steel plate, the steel foundry business of English Steel Castings Corporation, Limited, can be traced back for a century through the activities of Vickers, Limited, Sir W. G. Armstrong-Whitworth & Company, Limited and Cammell Laird & Company, Limited, whose steel interests were merged to form

FIG. 48.—*Typical example of large and intricate castings manufactured by Jarrow Metal Industries, Limited.*

E.S.C. in 1929. In 1855, the Vickers foundry was the first successful producer of steel castings in Great Britain and the cast-steel bells which Vickers introduced at this time subsequently became world famous. Moreover, the present site, formerly owned by Cammell Laird & Company, Limited, has contained a foundry for more than 90 years.

To-day, covering an area of nearly 420,000 sq. ft., and employing some 700 workpeople, the Grimesthorpe steel foundry is equipped with a very wide range of modern plant. At the outbreak of the second world war, it was the most highly-mechanized steel foundry in Great Britain and as a result, was able to make an immediate contribution to the then undeveloped production of armour quality tank parts.

Layout

It is on account of the wide range of products made at Grimesthorpe that this steel foundry's layout is entirely different from the majority of others of a similar nature in the United Kingdom. In the first place, it is divided into light and heavy departments, the former handling mass-produced castings ranging from a few ounces up to 7½ tons, together with individual castings of varying sizes, and the latter the heavier individual castings, the most recent of which weighed 185 tons. Each department is further sub-divided into smaller self-contained units according to the type of moulding involved, viz., greensand mass production, skin-dried mass production, specialized jobbing work and heavy pit and floor work. Greensand mass production, with railway work taking up as much as a quarter of the foundry's entire output tonnage, is the section where mechanization has been used to the greatest extent.

The light section itself has four mass-production units which are completely self-contained and served by their own sand plants and three electric arc-melting furnaces of 2½, 5 and 8/10 tons capacity. The units consist of a set of jolt/squeeze/pattern-draw machines suitable for castings up to 18 in. by 21 in. and weighing up to 100 lb.; jolt/roll-over machines capable of handling moulds for castings up to 500 lb. and measuring up to 3 ft. 6 in. square; a Sandslinger unit for greensand castings up to a weight of about 3,000 lb. and, most recently, a "Speedslinger" unit for greensand castings weighing up to 7½ tons. In every case, mechanized sand-conveyor systems are used. For the first two units backing sand is supplied from a common "Speedmullor" of American manufacture, which was the first of its kind to be installed in a British foundry. Similarly, the facing sand is produced in August Simpson type mills. The third unit is also self-contained and comprises a Sandslinger, a continuous sand mill, a large roll-over/pattern-draw machine, a mould conveyor, a knock-out station and a sand cooler. Designed primarily for the production of railway-bogie castings on a mechanized basis, it provides an interesting example of layout, specially planned to facilitate the quick and economic execution of fairly large work. The fourth and most recent unit, which began on an experimental basis 12 months ago and is now well on the road to full production, consists of a self-contained American Beardsley-Piper Speedslinger, capable of depositing moulding sand at the rate of a ton a minute.

FIG. 49.—*External fettling of turbine casing casting. (Jarrow Metal Industries, Limited.)*

The expansion of the heavy castings section which began immediately after the last war made it possible to bring the heavy moulding bay in direct line with the three Siemens acid open-hearth furnaces whose total capacity is 200 tons. The bay now contains four casting pits with a total length of 280 ft. and which vary in width from 16 to 24 ft., and in depth from 12 to 25 ft. To enable the maximum use to be made of the space available, each pit can be divided into a number of smaller sections by means of "shutters" developed by the corporation. In this way, the plant is capable of being used to maximum advantage, the deepest pits making possible the vertical casting of cylinders, whilst other items, amongst them the heaviest to be produced in the British Commonwealth, include rolling mill housings, turbine castings (including large stainless-steel types), press entablatures and crossheads such as the record-breaking 185-ton press castings sent to America in 1953 and 1954 (Figs. 51 and 52).

Also used in this foundry is the assisted feeding of large dry-sand castings, a method first brought to this country by E.S.C. some years ago, whereby a carbon arc is introduced to the feeder head after castings, ensuring a sounder finished product and reducing the necessary size of feeder head.

Core production is similarly divided into heavy and light sections, the bulk of the heavy work being done by hand, whilst the light production is divided between manual labour and a modern mechanical plant.

Attached to the foundry, but set in separate buildings, are ten fettling bays in all, four of them devoted exclusively to railway work and two to heavy work. Of notable interest in the medium and light fettling shops is the E.S.C. patent 20-in. swing-frame grinder, which was developed in these works

and now produced by Luke & Spencer, Limited, of Altrincham, Cheshire. Its excellent method of dust extraction seems to solve one of the worst problems in the campaign against silicosis.

For weighing the larger finished heavy castings the foundry possesses the world's biggest crane weigher designed to measure up to 200 tons in graduations of one ton.

The great range of castings produced includes a considerable amount for direct or indirect export. Automatic couplers which are in great demand for industrial purposes in Britain, are also being sent to Europe and directly or indirectly to many countries overseas.

Osborn Foundry & Engineering Company, Limited

The site now known as Rutland Works accommodated at one time some five or six independent companies' works, and although all but one of these have now come into the occupation of Osborn Foundry & Engineering Company, Limited, the steel-founding subsidiary of Samuel Osborn & Company, Limited, the task of organizing the old layouts and conflicting building lines to meet modern requirements is still to be completed (see Figs. 53 and 54 for typical work).

Nothing remains of the crucible melting systems which first supplied liquid steel, nor of the acid Siemens furnaces that followed them. By the time of the Congress visit in June, the Tropenas converter installation will have made way for a new arc-melting furnace, and all steel melting will be done electrically.

Two Foundries

There are two foundries. The Titan foundry, supplied by three electric arc-melting furnaces of 5,800 kva total rating, comprises four moulding bays and a coreshop bay.

One bay is devoted entirely to machine moulding in two shops, the smaller of which uses small plain jolt machines taking boxes 14-in. by 11-in., which are poured by hand shank, and work round a gravity-conveyor loop system, including a mechanical knock-out. The other, larger shop, also under gravity conveyor, is fed from two pairs of simultaneous jolt-squeeze/pin-lift and turnover machines with tables taking boxes up to 24-in. square. In this shop moulds are poured from stoppered ladles, and are hand-manœuvred to and from the ladle position. The conveyor system has ample storage capacity for cooling of moulds after casting.

At the knock-out, bottom plates are automatically stripped, castings are removed by an air-operated manipulator, and boxes are piled for batch-removal to the moulding machines.

Both these shops are supplied with unit sand by a single overhead conveyor, which also serves the adjoining bay. From the knock-outs, spent sand is cross-fed to the main underground return belt, to be reconditioned in a fully-mechanized sand-treatment plant designed around two Simpson mills.

The same sand-plant delivers sand across the gable ends of the next two bays, in which supplementary distribution can be effected by overhead crane.

The main bay, into which the melting furnaces teem, and that immediately beyond it, are devoted to large dry-sand and green-sand moulding and casting, using coke-fired stoves for drying. The southerly end of these bays comprises a moulding unit for boxes up to 4-ft. 6-in. square on simultaneous jolt-squeeze/pin-lift and pattern-draw machines, together with gravity conveyor and knock-out machine.

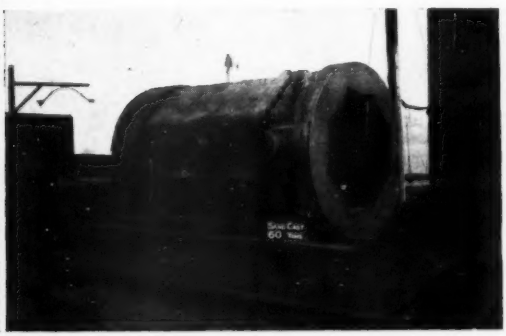


FIG. 50.—*Ingot moulds of* 40, 51, *and* 60 *tons in weight manufactured by the Brightside Foundry & Engineering Company, Limited.*

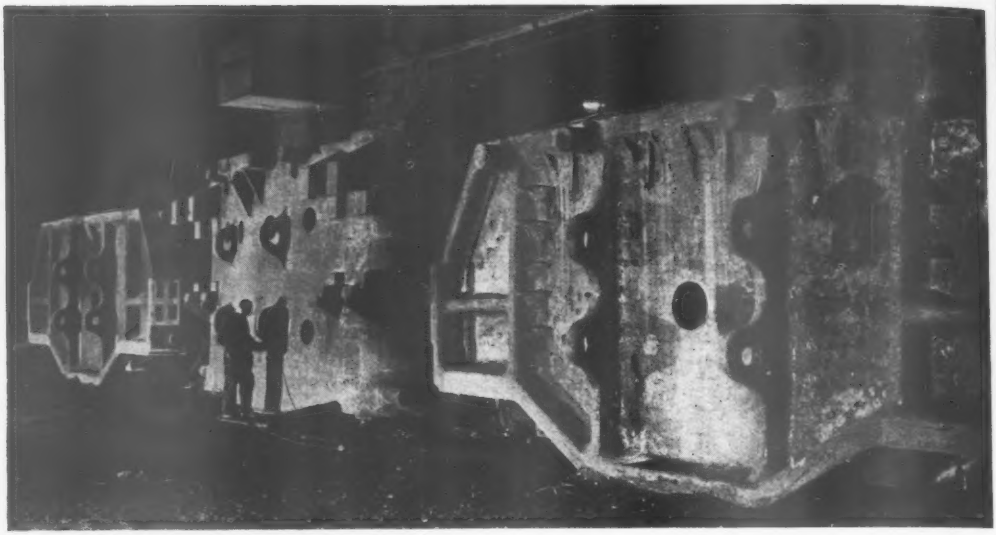


FIG. 51.—*154-ton and two 185-ton press castings for the American Defence Programme, produced at the Grimethorpe Foundry of English Steel Castings Corporation, Limited.*

In the fourth bay are moulded manganese-steel castings, and this bay has its own separate sand mill. Beyond it is the coreshop which serves both foundries and is equipped with one vertical and two horizontal core blowers, two vertical and two stationary core-drying ovens, sand dryer and core sand mixer. Benches for small work are equipped with a number of bench core-blowers.

Philadelphia Foundry

The Philadelphia Foundry, some distance away, and off the main building line, is served by an arc furnace and a small high-frequency induction furnace. Two simultaneous jolt-squeeze machines operate here, but the bulk of the work is floor moulded, and the sand-distribution system is by skip and crane, save for belt supply to the machines.

Fettling is carried out in three shops, each with some form of heat-treatment furnace, shot or grit blasting, and welding booths. Swing grinders are positioned over generously-sized grids through which the dust-laden air is drawn by large extraction fans, thus producing a highly-effective dust-removal system.

The high grade work accepted by this foundry requires close inspection of the bulk of the castings, supported by a full service of technical examination and control. The metallurgical laboratory is equipped with a good range of instruments for testing materials at normal and abnormal temperatures, and for making gamma-ray tests. Probe and induction magnetic-crack-detection instruments are in use as works tools, and pressure castings are regularly pressure-tested, in the fully-machined as well as the unmachined condition.

The range of castings made varies in size from

FIG. 52.—*Assembling cores in a mould for the 185-ton press casting at the Grimethorpe Foundry of English Steel Castings Corporation, Limited.*

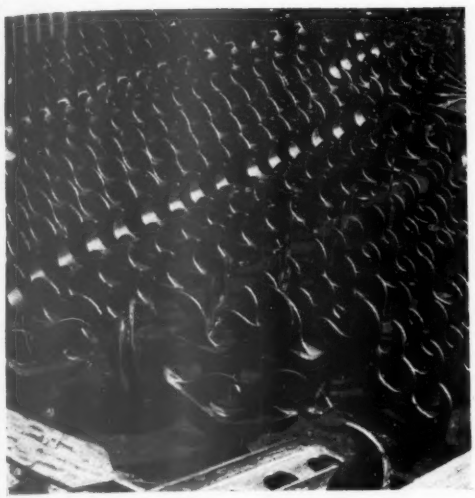


FIG. 53.—*Tube supports for oil-refinery fittings manufactured by Osborn Foundry & Engineering Company, Limited.*

less than two pounds to 8 or 9 tons, in composition from low-carbon steel to austenitic chrome/nickel steels, including a large tonnage of austenitic manganese-steel, and in application through a wide field of engineering, with special emphasis upon the oil-refinery branch, rock crushing, and earth moving, electricity generating and coal mining.

A fair proportion of the castings is supplied to customers fully machined. The machine section, which is at present divided between two shops, is in process of being re-equipped. A turret-lathe section deals with light work, and a fair range of heavier lathes, vertical and horizontal boring mills, radial drills and ancillary machine tools is supplemented by a small tool room.

The majority of patterns used are made in the company's patternshop, which has been recently refitted with new woodworking machines. Drawing offices and print room are sited in a roof-span of the patternshop.

Production control is effected by a system devised by the company's officials to meet the precise conditions of variety in order book peculiar to this foundry. Cost control is maintained by a standard costing system, working on ten 5-weekly periods per year of 50 working weeks.

Clothes lockers and washing facilities are provided near the works gateway and adjacent thereto is the respirator service room, in which each employee's spare respirator is cleaned, disinfected and reconditioned daily. In this same area are sited the ambulance room and works medical officer's consulting and examination rooms, and here also the X-ray travelling van is parked at its periodic visits.

The steel foundry participates in the apprentice training scheme of the parent company under which apprentices who reach the necessary standard obtain a Craftsman's Certificate certified jointly by the company and a trade union.

William Beardmore & Company, Limited, Parkhead Steelworks Glasgow

A large proportion of the production at the Parkhead Foundry of Wm. Beardmore & Company, Limited, consists of steel castings of substantial tonnage. Within a weight range of from 5 to 150 tons, the foundry makes castings for ships, turbines, hydro-electric and steelworks plants, hydraulic presses, and other heavy engineering purposes. The works has always been an important source of supply for the shipbuilding yards of the Clyde and elsewhere. The stern, bow hawse-pipe, stern frame and rudder, inner and outer propeller-brackets of the Queen Elizabeth were cast and machined for assembly at Parkhead, and similar parts have been provided for many other Cunarders and large passenger liners, and for the Royal Navy's biggest warships. Orders have been completed recently for a set of roll-housings for an Australian steelworks and for hydraulic-press components of from 90 to 132 tons finished weight, which were part of an order for the US defence programme.

Patternshop

The patternshop (Fig. 56) is divided into three bays—a machine bay, building bay, and a bench

FIG. 54.—*Core for tumbler casting being placed in position at Osborn Foundry & Engineering Company, Limited.*

FIG. 55.—*An example of a pit mould at William Beardmore & Company, Limited.*

bay. The floor of the building bay is 120 by 50 ft. and has been specially levelled so that it can be used as a drawing and building board for the stern-frames of ships and other large patterns. The patternshop is fully equipped and is operated both for the manufacture of new patterns and the repair or modification of customers' existing patterns.

Moulding Shop

Post-war extension and reconstruction has doubled the capacity of the moulding shop, and it is now 1,000 ft. long, 70 ft. wide and 60 ft. high. The size and nature of the steel castings produced necessitate the use of pit moulds, of which an example is shown in Fig. 55. There are 16 casting pits of various sizes, the largest being 45 ft. long. 30 ft. broad, and 12 ft. deep. All employed in the moulding bays are highly skilled craftsmen.

The company manufactures steel castings in both carbon and alloy steels, and the steel foundry is supplied with metal from the works' central melting shop which is equipped with Siemens acid-open-hearth furnaces, three of 70 tons, one of 45 tons, and one of 35 tons capacity, and two basic electric-arc furnaces of 20 and 10 tons capacity. Some of the largest castings need as long as 2 to 3 weeks to cool, and the dressing shop, to which they are subsequently transferred, is under the same roof as the moulding shop, and is of similar dimensions. Separate sections are maintained for rough and finished dressing, and the shop is fitted with modern equipment. Of major interest at this foundry is the arrangement for bulk-annealing. The largest furnace for this purpose is 40 by 30 by 12 ft. deep and is oil-fired, with a modern control panel from which sequence regulation is possible. The visitors will also be impressed by the fettling sections (including large shot-blast rooms) and the extensive forge shops, machine shops, and laboratories.

The company gives every encouragement to its apprentices. They are allowed a day off each week to attend classes, and bonuses are paid both for academic success and good attendance. The company provides the usual amenities, including canteens and medical services on a scale commensurate with the size and scope of its operations.

FIG. 56.—*A fully-equipped patternshop at William Beardmore & Company, Limited.*

North Eastern Marine Engineering Company, Limited

The Wallsend works of this company is the headquarters of a group of marine engineers consisting of the North Eastern Marine Engineering Company, Limited, Richardsons Westgarth (Hartlepool), Limited, and George Clark (Sunderland), Limited. These associated firms, with four large works—one of which is situated at Wallsend, two at Sunderland and the fourth at Hartlepool—are

actively engaged on the production of geared turbines, diesel engines and steam-reciprocating engines for large and small vessels. The group also builds water-tube boilers of Foster-Wheeler type, Scotch boilers and marine superheaters. In addition, at the Hartlepool works, turbo-alternators up to 60,000 k.w. for power stations are manufactured, together with the necessary ancillary equipment. Two large iron foundries, one at Wallsend and the other at Hartlepool, produce the castings required by all the works. These include high-duty iron castings, by the Lanz Perlit process, for diesel engines, superheated-steam engines and other severe conditions of service. Spheroidal-graphite cast iron is also manufactured under licence. In addition to these special items, the production covers a wide range of iron castings up to a maximum weight of 35 tons. Integrated with the work of the foundries and other departments is a large metallurgical laboratory, situated at Wallsend, equipped with modern mechanical testing machines and photo-micrographic apparatus and having full facilities for the chemical analysis of metals and alloys. It is also equipped for the testing of lubricants and fuels (both solid and liquid) and for the investigation of the many problems incidental to the business of large marine engineering works.

The Wallsend works, which will be visited by some of the overseas delegates to the International Foundry Congress, is situated about midway between Newcastle and Tynemouth. The south end of the works fronts directly on the river Tyne, with a piled deep-water jetty 1,500 ft. long having craneage facilities up to 150 tons, enabling several ships to be fitted out at the same time. The main shops lie north and south, the erecting shop being in the centre and having a broad gauge rail track running direct to the jetty for conveying loads up to 150 tons. To the west, the erecting shop is flanked by the large machine shop and main foundry (Fig. 57) and, to the east, by small machine shops, fitting shops and boiler shop. The main output at present consists of N.E.M.-Doxford oil engines in powers ranging from 2,000 to 10,000 h.p. per shaft. The chief subsidiary line of business is the manufacture and fitting of superheaters to new ships and the conversion of existing ships to the use of super-

FIG. 57.—*Main foundry bays at North Eastern Marine Engineering Company, Limited. In the foreground are shown several castings typical of those undertaken.*

heated steam. During their tour of the works, the visitors will have the opportunity of seeing a number of these engines at various stages of manufacture, from the production of the necessary patterns, castings and fabricated parts to completed engines ready for shop trials.

Iron Foundries

The iron foundries consist of two large shops, one being part of the main works and the other a separate building on the east side, and are at present being extended and re-organized. The east foundry is 250 ft. long, 70 ft. wide, with a height to the eaves of 45 ft. and has six large core-and-mould drying stoves, all the castings produced being made in dry sand or loam mould. Stripping and fettling work and sand preparation are confined to one end of the shop, being separated from the moulding and coremaking area by a high partition. The chief castings produced are cylinder liners, cylinder heads, pistons, scavenge pump covers, exhaust belts and flywheels for diesel engines; also propellers up to 18 ft. 6 in. in dia. and 16 tons in weight. In an annexe to the foundry, facilities for washing, including showerbaths, footbaths and hand basins, together with clothes-locker accommodation for over 100 men, are provided. Full advantage of these facilities is taken by the workers.

The main foundry is at present undergoing considerable extension and re-organization, an adjoining machine shop having been taken over in order to provide room for a separate fettling shop, to enable the brass foundry to be enlarged and generally to improve the layout and organization of the foundry as a whole. Included in the scheme is the provision of washing facilities on similar lines to those at the east foundry. On completion of the alterations, the total floor area of the shop will be 33,500 sq. ft. The production of this shop consists of cylinders, bedplates and other castings for marine steam engines, cylinder blocks, bedplates and other main items for diesel engines, together with small castings such as valves, branch pieces and small engine parts which are cast in green sand. The production of the brass foundry consists of pumps, liners and stern-tube bushes in gunmetal and brass and a wide range of small gunmetal and phosphor-bronze castings for engine parts, valves and fittings.

The total number of men employed in the works is 1,650, of whom 217 are in the foundries.

Machine Shop

The large machine shop is well equipped with a variety of machine tools capable of dealing with the larger components of marine installations. In it will be seen several large lathes employed in turning crankshafts, lengths of intermediate shafts and tail shafts together with stern tubes, cylinder liners and running gear components such as connecting rods, piston rods and skirts. Large horizontal and wall planers are employed for machining bedplates, columns, entablatures and guides to-

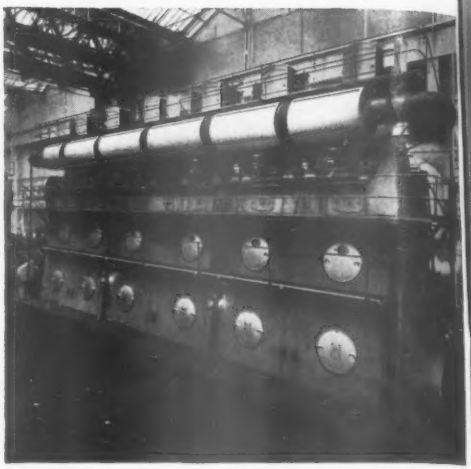


FIG. 58.—*Hawthorn-Doxford engines constructed at St. Peter's Works, Hawthorn Leslie (Engineers), Limited.*

gether with a large plano-miller which can be adapted for milling or boring. Several boring, milling and drilling machines are employed in machining crankshaft components, cylinder liners, spherical bearings, and main bearing pockets of large bedplates. The building of large crankshafts of the built-up type is carried out vertically in a special pit designed for that purpose with final checking on an accurate machined bed.

Erecting Shop

The erecting shop is situate adjacent to the large machine shop which facilitates easy transport of the heavy components to the erecting shop which has three erecting beds capable of accommodating the largest engines together with two subsidiary beds, all having thick concrete foundations with accurately-levelled machined girders flush with floor. Permanent test-bed equipment is installed comprising cooling water and lubricating oil pumps, coolers, filters, fuel output and power being absorbed in a 10,000-b.h.p. "Froude" dynamometer.

The small machine shops extend over three bays to the east of the erecting shop and are equipped with a variety of machine tools capable of dealing with the smaller engine components. Of special interest in the recently built east machine shop will be seen an electronic lathe specially designed for the rapid turning of large bolts from master profiles. Adjacent to the small machine shops are the fitting shop, brass finishing shop, and boiler shops. The main shops, including the main foundry, are heated with a recently-installed system of radiant heating by forced circulation of hot water under pressure through a number of strategically-placed panels.

FIG. 59.—*Patternshop of Hawthorn Leslie (Engineers) Limited. In the foreground is shown one of the marking-off tables for large projects and in the centre of the shop is a semi-skeleton pattern for a turbine casing.*

Hawthorn Leslie (Engineers) Limited

The St. Peter's Engine Works of Hawthorn Leslie (Engineers) Limited, which are to be visited by the members, are situated on the north bank of the river Tyne about one mile downstream from the bridges at Newcastle-upon-Tyne. The present site of some 19 acres was acquired in 1870 for the purpose of extending the marine-engineering side of the business which had commenced in the year 1820 with the building of several small sets of engines for fitting on board steam packets running on the river. Since 1870 the history of the establishment has been one of consistent development and at the present time steam-turbine installations and marine oil-engines are being produced at a rate of 80/90,000 s.h.p. per annum, not only for their associated shipyard at Hebburn-on-Tyne, but for various shipbuilders in Great Britain and abroad.

The building of turbine machinery by the company dates from the year 1909 when the destroyer, H.M.S. Ghurka, was built and engined for the Admiralty. Subsequently the plant and organization of the works has kept pace with the progressive development in marine turbines, particularly in warship machinery for which the company has built installations up to the highest powers for all types of vessels. The company has now under construction and on order a large number of sets of double reduction-geared turbines for merchant ships including vessels of the supertanker class, designed to operate under advanced steam conditions up to 600 lb. per sq. in. working pressure and 510 deg. C. The present designs of turbine machinery are the result of research and experiments carried out by the Parsons and Marine Engineering Turbine Research and Development Association (PAMETRADA) of which the company is a founder member. The requisite boilers for these advanced steam conditions are also manufactured at the St. Peter's Works, and include the Foster Wheeler, Babcock & Wilcox and Yarrow types with their superheaters, air heaters and economizers. Condensers of all sizes for both marine and land use are also built. The marine diesel machinery manufactured by the company comprises the Doxford, Sulzer and Werkspoor types, all of which will operate on heavy oil or diesel oil as owners may require.

The recent advances in supercharging are being incorporated in all these types of engines. Facilities are provided for exhaustive shop tests on these engines by means of a powerful hydraulic dynamometer (Fig. 58).

Shops to be Visited

The various shops to be visited by the members are as follow:—

Foundry and Patternshop

The foundry, which supplies most of the ferrous and non-ferrous castings for the engine works, is partially mechanized and has a main bay 320-ft. long. Out of a combined annual output of over 1,200 tons, approximately 50 per cent. of the iron, gunmetal and aluminium castings produced are machine-moulded. A controlled ventilating system and gas-fired space heating are installed. The adjoining chemical and metallurgical laboratory includes in its equipment a 50-ton testing machine. Patterns are made in a spacious and well-lighted patternshop, equipped with the latest types of woodworking machinery (Fig. 59).

Boiler and Welding Shop

The equipment in this shop has been completely renewed so as to provide the most modern facilities for the construction of large fabricated steel-welded parts, now increasingly a feature of marine machinery, including turbine casings, gear cases, condensers, diesel engine bedplates, entablatures, columns and other principal parts. The re-equipment includes the provision of a large gas-fired stress-relieving furnace and a shot-blast plant. Full provision for the moving of the extra weight

required under modern conditions is made by the use of powerful overhead-travelling cranes.

Valve Shop

Many of the castings produced in the foundry proceed to the valve shop for machining and fitting. Large quantities of valves, etc., are produced for other shipbuilding and engineering concerns, particularly cargo sluice valves for oil tankers.

Machine Fitting and Erecting Shops

These shops are the subject of continuous modernization.

The shops are served by a number of overhead-travelling cranes capable of lifting up to 120 tons and large concrete test-beds are installed in the erecting shop for the full power-testing of diesel engines by means of the latest type of dynamometer. Equally efficient facilities are also available for the steam testing of turbines. The associated coppersmiths' shop, brassfinishers' shop, and blacksmiths' shop include in their equipment a range of modern hydraulic pipe-bending machines and pneumatic hammers. The manufacture of turbine blading to a very high standard of accuracy is an important feature of modern turbine design and, in the turbine-blade shop, special study has been made of the equipment and control necessary to achieve this end.

FIG. 60.—*General view of the large-castings bay at C. A. Parsons, Limited. Note the heavy-capacity motive-type Sandslinger running the length of the shop.*

C. A. Parsons & Company, Limited, Newcastle-upon-Tyne, 6

The Heaton Works of Messrs. C. A. Parsons & Company, Limited, were founded in 1889. Sir Charles A. Parsons, the founder, established them in order to have greater facilities for the development of steam turbines and high-speed electrical generators than were available at Gateshead where their manufacture had been commenced in 1884. The Works are located on Shields Road about two miles from the centre of the city, and when first opened occupied a site of about two acres and comprised a single shop measuring 170 ft. by 50 ft., in which turbo-dynamos were built, a small patternshop, smiths' shop, testing room and an office. The entire staff numbered only 48. From such small beginnings have been built up the Heaton Works of today. These now cover an area of 53 acres, including the welding shops and foundries at Walkergate and the optical works, while over 6,000 persons are on the payroll of the firm.

The principal efforts of Heaton Works are directed to the development and manufacture of turbo-generating plant, up to the largest sizes for central power stations.

In addition to steam turbines and turbo-generators of all kinds, turbo-blowers and compressors, surface-condensing plant and transformers are also manufactured. The design and construction of astronomical telescopes is another class of work for which the Parsons company is famous. This work is carried out in a special department of Heaton Works known as the optical works and trades under the name of Sir Howard Grubb, Parsons & Company.

FIG. 61.—*Rough castings stockyard. (Glenfield & Kennedy, Limited.)*

When the works were founded in 1889, the largest turbine constructed was for an output of 75 kw.: this machine was installed in the Forth Banks power station of the Newcastle and District Electric Lighting Company, and was the first steam turbine to be used in any public power station. By the year 1900 the size of single machines had reached 1,000kw., whilst in 1923, a 50,000 kw. turbo-alternator was built and despatched to Chicago for service in one of the largest generating stations in America. This machine was constructed as a three-cylinder cross-compound unit, the low-pressure rotor running at a speed of 720 r.p.m. By 1930 it was possible to build turbo-alternators for the same output to operate at 1,500 r.p.m., while after a further seven years there was constructed at Heaton Works a 50,000 kw. turbo-alternator to operate at 3,000 r.p.m. Turbo-alternators for outputs of 100,000 kw. when running at 1,800 r.p.m. are now in operation and further machines for the some output and for 120,000 kw. to operate at 3,000 r.p.m. are under construction at the works.

Foundry

The party will visit the foundry which has an annual output of about 3,000 tons covering a wide range of sizes and weights of castings. It is divided into three main units—a light section producing castings from a few ounces to about 100 lb.; a medium section handling from about 100 lb. up to 5 tons; and a heavy bay producing castings up to 40 tons in weight. Placed between the heavy bay and that containing the medium and light sections is a totally-covered stockyard serving two 54-in. dia. and two 24-in. dia. mechanically-charged cupolas. Fig. 60 shows the heavy section, where, in addition to the normal overhead cranes, independent electric travelling jib wall cranes are provided; also a large motive type sand slinger with 10-ton capacity interchangeable hoppers runs down the centre of the bay and is so positioned that it can reach all the pits; and, finally a large sand-handling, mixing and recovery plant is installed at the end of the bay. Sand, including that user by the sandslinger, is delivered ready for use to each pit by skip, and wheelbarrows have been eliminated.

In the light and medium sections illustrated in Fig. 60, again all handling is kept to a minimum. Sand preparation and milling plants are conveyor and elevator fed and deliver sand, carefully controlled for moisture, permeability and bond strength *via* an overhead conveyor to hoppers at each moulder's hand gives him an immediate supply of sand into his box, while any sand spilled passes through a grating to an under-floor conveyor, which returns it to the sand-preparation unit. All boxes are closed on roller conveyors feeding to the pouring line, after which they move by conveyor to a mechanical knockout machine, the sand falling through gratings and being returned to the sand plant. Sand is never moved by hand in these sections of the plant.

All machining and erection of turbo-generating plant and transformers up to the largest sizes is undertaken at Heaton Works while the works at Heaton South is devoted to the preparation of core plate, turbine blading and the fabrication and bending of high-pressure steam pipes.

The turbo-alternator erecting shops adjoin the heavy machine shops and all machines are erected here. Depending on their destination they may be run up to speed. Machines varying in size from 6,000 kw. up to 120,000kw. are at the present time under erection.

The alternator shop is one of the finest in the country and all work in connection with the stator core building and winding is undertaken here. Towards the centre of the shop is a large reinforced-concrete foundation block for the erection and testing of the complete alternators. At the east end of the shop is the impregnating plant. In the shop are alternator stators, for capacities up to 100,000 kw. in various stages of construction.

To meet the increasing demand for large power transformers a new shop has recently been completed adjacent to the existing transformer shop and it is equipped with modern plant necessary for the manufacture of E.H.V. transformers of the largest ratings for system voltages of 300 kv. and higher. A test section is included in the shop as it is the policy of the company to provide facilities for per-

forming full-load loss tests and heat runs on all sizes of transformers being manufactured, and plant is installed that will fulfil this requirement. An impulse generator with a nominal output of 2.5 million volts is installed for the testing of large transformers and with the highest voltage envisaged for many years.

The interior of the whole works including the machine tools are painted in stimulating colours. The roofs are sky blue to give a receding effect, the walls a warm sunshine colour and slow-moving parts are orange, bedplates and fixed parts are in a restful shade of green.

Glenfield & Kennedy Limited, Kilmarnock

Glenfield & Kennedy has grown up with the ever-increasing use of water. It began in 1852, early in the growth of regulated water supplies, when Thomas Kennedy, realizing the need for an efficient device for measuring and recording water consumption, was granted a patent on his design of a water meter, and with three associates formed a private syndicate to acquire the patent rights and to finance the manufacture and marketing of the invention.

By 1865 the meter was successfully established in the waterworks world, and in that year the syndicate was reconstituted as the Kennedy Patent Water Meter Company, Limited, and the Glenfield Company, Limited, was formed. The latter, an iron founding and general engineering concern, made castings for the Meter Company and later became the more important of the two by widening its interests and establishing a valve and other hydraulic-equipment business destined to be among the foremost of its kind. In time, the interests of the two companies became so closely connected that fusion was not only desirable but a natural development. Thus were laid the foundations of Glenfield & Kennedy, Limited, which was formed on the amalgamation of the two concerns in 1899.

To-day, the company has an extensive factory at Kilmarnock that occupies a site of some 40 acres, employs upwards of 2,500 people and apart from steel production is self-contained; a number of offices at home and in India; and agents in most other overseas countries.

Iron Foundries

The foundries, ranking among the best equipped in Britain and producing castings principally for the company's own needs, comprise heavy and repetition iron foundries using only Meehanite metal in a range of grades from 14- to 20-ton tensile, and a non-ferrous foundry, for which a new building, equipped with a complete handling plant for the delivery and return of sand and ducting for conveying fumes, is at present under construction.

In the heavy foundry, which has a capacity of some 70-ton of finished castings per week, with an individual limit of 32-ton, green-sand, dry-sand and loam moulds are made. A pit, 32-ft. deep and having a clear length of 28-ft., enables large hydraulic cylinders and rams to be cast vertically, and thus ensures perfect soundness of metal. The repetition foundry has a total output of 300-ton per week, of which some 175-ton are produced in

FIG. 62.—*General view of east engineering department at Glenfield & Kennedy, Limited.*

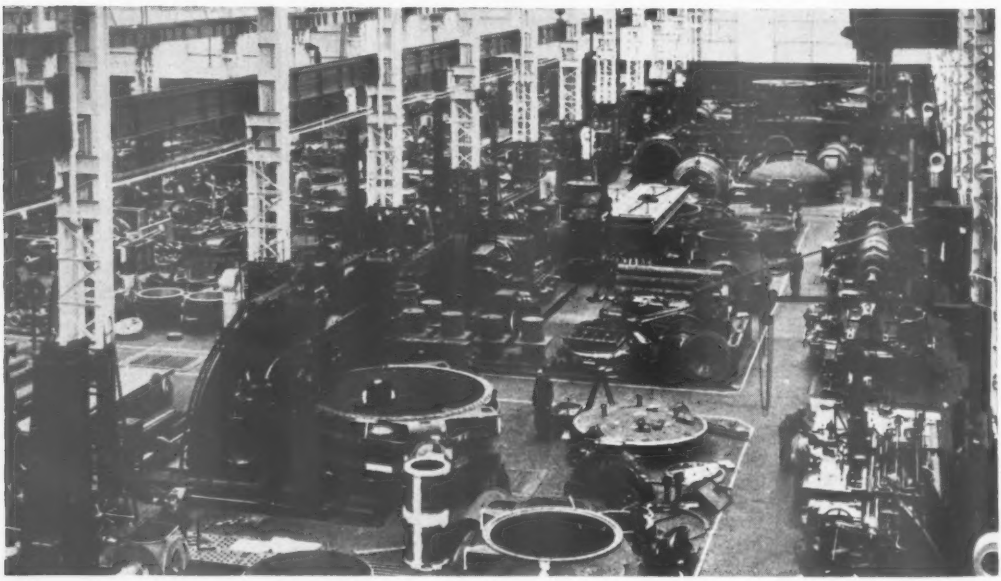


FIG. 63.—*Bottom teeming of a large casting in the steel foundry of Babcock & Wilcox, Limited.*

a fully-mechanized section. In this section, the moulds are made in green-sand on machines of various types, supplied with sand from a central conditioning-plant, with a total capacity of 30-ton per hour, by overhead distribution belts. The melting arrangements of these two foundries comprise five cupolas, one 27-in., three 48-in., and one 60-in. dia., two being blown each day.

Non-ferrous Foundry

The non-ferrous foundry produces a wide range of alloys, including forging alloys, required for the many different components of the company's fluid-handling manufactures. It has an output of some 40-ton of metal per week, and is provided with a number of oil and coke-fired furnaces, ranging in capacity from 200-lb. to 10-cwt.

The engineering sections of the factory comprise, principally, east and west engineering departments. The former (Fig. 62) caters for the machining, fitting, assembly and test of large valves, sluices, sluice gates, hydraulic cylinders, etc., and the latter for ranges of standard valves, up to 14-in. dia., and other fittings. Material is routed from a castings stockyard (Fig. 61), through the machines to the store, whence it is issued on to assembly conveyors and then passed to a hydraulic-test department for proving. Also in the building is an instrument department, a sub-tool room and an apprentice training school.

Babcock & Wilcox, Limited

Rebuilt and re-organized immediately prior to the war, the Renfrew foundries of Babcock & Wilcox, Limited, can be regarded as an up-to-date example of a "mixed" foundry, employing about 700 people, and engaged on quantity and jobbing production of a wide variety of iron and steel castings.

Steel Foundry

Steel castings produced range from a few pounds to about four tons, the average output being in the region of 1,800 tons per year.

Moulding equipment includes two groups of machines with mechanical sand-handling and roller tracks. One group contains two 4,000-lb. and two 750-lb. Pneulec-Hermann jarr/ram/roll-over machines for the quantity production of castings from 28 lb. to 1 ton in boxes 2 ft. to 4 ft. square. The second group, for castings up to 28 lb., is made up of three MacNab jolt-squeeze machines. A plain jolt-ram machine is used for castings up to 2½ ton.

Melting is carried out in Heroult-type tilting arc furnaces, there being two of 3 ton capacity and one of 15 cwt. capacity. The 15 cwt. furnace is normally employed on alloy steels (chiefly the Babcock "Calmet" alloy) and the oxygen lance is normally employed on most melts. Bottom-pouring ladles are used (Fig. 63), and gas-heating equipment is installed to ensure perfectly dry ladles.

For heat-treating castings, two types of annealing furnace are used. One is of the double-ended type with two bogies, one being loaded or unloaded when the other is in the furnace. The other is of the "cover" or "top-hat" type in which the furnace is transferred by crane from one base to another at will.

Iron Foundry

The iron foundry is capable of producing some 21,000 tons per year of castings which vary from a few ounces to 6 tons, the largest casting regularly handled being a baseplate for a pulverizing mill 16 ft. by 6 ft. 6 in. by 1 ft. 6 in.

Links for travelling and chain grate stokers form a major item in the foundry output, these can be produced in quantities of up to 30,000 a day by fully-mechanized production methods, which include a continuous casting line and mechanical handling from the knock-out station. The hydraulic moulding machines used were designed within the Babcock organization and are interesting in that they produce both halves of a complete boxless mould in one squeeze instead of the separate production of cope and drag on different machines. From the knock-out station sand is reclaimed by a completely-mechanized plant at the rate of 30 tons per hour.

Quantity production of small castings is also carried out in snap-flask moulds, produced by a battery of Jackman jolt-squeeze machines. A considerable amount of hand moulding is also carried out, and there is a comprehensive installation of jolt-rollover machines. Sandslingers, etc. An

FIG. 64.—*Collecting metal at one of the five balanced-blast cupolas at Babcock & Wilcox iron foundry. Note the use of a tip-up trough at right angles to the cupola spout, to deliver into ladles on alternate sides.*

interesting item of equipment is a newly-installed gas-fired skin drier of portable design to deal with moulds too large to be conveniently handled in a drying oven.

Cores are manufactured in an up-to-date core department, the core-makers working adjacent to a roller track which carries the cores to one of two core ovens, one oil-fired with 2¼ hour, and one gas-fired with a 1½ hour drying cycles.

Metal is provided by five cupolas of the balanced-blast type, four being of 9 to 10 ton capacity and one of four ton, the latter being used for the production of metal for heat-resisting alloy castings. The method of preparing cupola charges and the actual charging arrangements (designed and built within the organization) are of interest. The cupolas are centrally situated for easy metal-distribution over the foundry, which is carried out by drum-type bogies. An interesting item is the slag-disposal machine situated near the slag taphole of each cupola. In these the slag is first quenched and disintegrated and finally removed by a worm conveyor to barrows or trucks for disposal (Fig. 64).

Melting is also carried out in two 400 lb. capacity oil-fired crucible furnaces, which are normally used on heat-resisting irons for furnace materials. Production of alloy castings approximates to 10-15 ton per week.

A comparatively recent (1948) modification to the dressing or fettling department is the replacement of shot-blasting by the "Hydroblast" system utilizing jets of sand and high-pressure water. This has not only very considerably reduced the time taken for fettling most castings, but enables a considerable quantity of sand—once a nuisance to dispose of—to be reclaimed, graded, dried and returned to the main foundry sand system.

Renfrew Foundries, Limited

Renfrew Foundries, Limited, is comparatively new as a commercial company, as it was not formed until the latter half of 1945. Prior to that date it had during the years of war, as an integral part of the Rolls-Royce Scottish shadow factory, produced a vast tonnage of aluminium castings for many thousands of Merlin aero-engines, manufactured in Glasgow. As with most companies of recent formation, the process of consolidation and expansion has taken time, but within seven years a reputation has been earned in all branches of British engineering, for high quality of castings produced in aluminium and its alloys, by the various processes of sand casting, gravity-die-casting and high-pressure die-casting.

The foundry, which is numbered amongst the largest mechanized aluminium foundries in Europe, is planned as a completely self-contained unit, having under its control the manufacture of all ancillary equipment, such as sand casting patterns and both gravity- and high-pressure dies.

Engineering contracts of a highly diverse nature are undertaken and, in recent years, the largest proportion of the civil contracts are taken by the motor industry, closely followed by the office-equipment industry, domestic equipment and marine industries.

The foundry is making nowadays a special feature of the production of high-pressure die-castings, of a size and nature which some years ago were considered to be outside the capabilities of this form of die-casting. By association with the Doehler-Jarvis Corporation of America, which is acknowledged to be the largest producer of high-pressure die-castings in the world, Renfrew Foundries maintain their up-to-date knowledge of technical advancement. It is a claim of this foundry that no casting is too large, too small or too intricate, and it is hoped that the visitors will find full substantiation.

Synopses of the Technical Papers

In recognition of the fact that this is an International Conference and Congress, for each of the nineteen technical papers to be presented, synopses have been provided in three languages — English, French, and German — and are reproduced in these pages. Also included are portraits, where available, of the Authors of the papers and brief biographical particulars. Many of the Authors will be attending the Congress in person.

Paper No. 1119: **"Evaluation of Casting Processes," by Hiram Brown, B.S. (American Exchange Paper).**

MR. HIRAM BROWN, who is the Author of the official American Exchange Paper, received his early technical training at Fenn College, Cleveland, Ohio, graduating with a B.S. degree in metallurgy. After graduation, he spent four years at the Detroit plant of Alcoa as foundry metallurgist, following which he served for a similar period with The Frontier Bronze Corporation, Niagara Falls, New York, as chief metallurgist, and while in this latter position Mr. Brown perfected the aluminium alloy known as 40E. After spending eighteen months with Aluminium Industries in Cincinnati as assistant works manager and later as works manager, he was appointed in 1946 to his present position of company chief metallurgist to the Solar Aircraft Company, Des Moines, Iowa. He is also a member of the corporate staff of this firm. Considered as one of the outstanding Americans in light metals metallurgy, Mr. Brown has done pioneer work in the field of high - temperature alloys, in addition to which he has had considerable experience in sand permanent moulds, die, plaster and investment casting of light metals, copper-base and nickel-base alloys and sand and shell moulding of stainless steels. A member of the American Foundrymen's Society, American Society

The object of the Paper is to point out the advantages of castings for many applications, and the advantages or limitations of the various foundry methods. These points are weighed against the fact that in far too many cases castings are fighting to survive. The reason for this is ascribed to a number of factors: (1) *Ignorance of casting design and desirability on the part of designers;* (2) *casting too often is used only as a substitute for another process instead of a component actually being designed for casting from the start;* (3) *poor quality of castings from many sources;* (4) *too much effort expended in taking business from some other type of casting rather than taking jobs away from competitive industries; and* (5) *stifling the interchange of foundry knowledge and failure to get maximum results from established casting methods.*

The situation is reviewed from the technical viewpoint of close association with foundrywork, and from that of actually having to recommend the use of castings, purchase them, and inspect them for comformity to high-quality standards. Since high-quality standards are here to stay, it is recommended that two steps be taken: (1) *Start engineers thinking about castings while they are in college, and* (2) *foundrymen must accept high-quality standards and make every effort to improve their casting processes to meet those standards rather than constantly complain that quality requirements are too severe.*

"Revue des Techniques de Fonderie," par Hiram Brown, B.S. (Mémoire d'échange de la American Foundrymen's Society).

Ce mémoire cherche à souligner l'avantage que présente la fonderie dans de nombreux domaines, tout en délimitant le champ d'application des différents procédés de coulée. En effet la fonderie semble dans bien des cas avoir beaucoup de peine à combattre la concurrence. Ceci est la conséquence de plusieurs facteurs : (1) *Ignorance des dessinateurs en ce qui concerne l'étude des pièces et les possibilités de la fonderie;* (2) *Production de pièces appelées à remplacer d'autres pièces obtenues par un procédé de manufacture différent, et non pas conçues à l'origine comme des pièces de fonderie;* (3) *Mauvaise qualité de nombreuses pièces livrées aus clients;* (4) *Efforts trop fréquents de concurrencer des procédés de fonderie différents au lieu de chercher à faire mieux que les fonderies de même catégorie;* (5) *Refus de collaboration technique entre fondeurs et incompétence dans l'application des procédés éprouvés.*

Le mémoire insiste sur l'aide technique à apporter au travail dans la fonderie et l'importance des services d'études destinés à guider le client, et des services de ventes. Il souligne la nécéssité des inspections assurant une production de qualité. Puisque le client sera toujours exigeant, l'auteur suggère de (1) *commencer à initier les ingénieurs aux techniques de la fonderie pendant leurs études, et* (2) *rendre les fondeurs concients de la nécéssité de couler des pièces de bonne qualité, et les persuader de chercher à les obtenir plutôt que de se plaindre de la difficulté à surmonter.*

"Bewertung von Gussverfahren," von Hiram Brown, B.S. (Austauschvortrag der American Foundrymen's Society).

Der Zweck dieses Vortrages ist aufzuzeigen, wie für viele Anwendungsfälle Formung durch Giessen anderen Formgebungsprozessen überlegen ist und die

of Metals and American Society of Testing Materials, he is author of the book "Aluminium and its Applications" and has also written numerous articles for technical publications. Well known as a lecturer, Mr. Brown has lectured to numerous national and local technical and non-technical groups and at a number of American universities.

Vorteile und Beschränkungen der verschiedenen Giessereiverfahren klar zu machen. Diese Gesichtspunkte werden gegen die Tatsache abgewogen, dass in viel zu vielen Fällen Abgüsse um ihre Existenzberechtigung zu kämpfen haben. Die Ursachen sind verschiedenen Umständen zuzuschreiben: (1) *Unkenntnis des Entwurfbüros hinsichtlich der Erfordernisse und der Erwünschtheit von Gussteilen;* (2) *Giessen ist oft nur als Ersatz für eine andere Herstellungsmethode gedacht, anstatt den Bestandteil von vorneherein als Abguss zu planen;* (3) *minderwertige Gusslieferungen von verschiedenen Erzeugern;* (4) *übergrosse Anstrengung der Giessereien neue Anwendungsgebiete ihrem Erzeugungsprogramm anzufügen, anstatt auf eigenem begrenzten Gebiete mit Konkurrenzbetrieben in Wettbewerb zu treten; und* (5) *Verhinderung des Erfahrungsaustausches zwischen Giessereien und Nichterreichung der besten Ergebnisse, welche mit festbegründeten Gussmethoden erreichbar wären. Der Vortragende betrachtet diese Probleme vom technischen Gesichtspunkte eines Mannes, der mit Giessereierzeugnissen enge verbunden ist, dessen Aufgabe es ist, die Anwendung gegossener Bestandteile zu empfehlen, solche Abgüsse zu kaufen und zu überprüfen, ob diese den Übernahmsbedingungen für höchste Gütewerte entsprechen.*

Da die hohen Qualitätsanforderungen eine bleibende Angelegenheit geworden sind, wird empfohlen, zwei Massnahmen zu ergreifen: (1) *Konstrukteure und Zeichner sollen bereits während ihrer Studienzeit dazu gebracht werden über Gussteile nachzudenken;* (2) *Giessereifachleute müssen sich den immer höher werdenden Qualitätsanforderungen anpassen und nicht ständig erklären, dass die Erfordernisse zu schwierig gestellt seien.*

Paper No. 1120: "Residual Stresses in Castings," by A. Portevin, and J. Pomey (French Exchange Paper).

PROFESSOR ALBERT PORTEVIN was born in 1880, and has achieved an international reputation as a metallurgist. His outstanding ability has been recognized both in France—where he is a Commander of the Legion of Honour and a member of the *Institut de France*—and in the U.K. In this country, he is both a Carnegie and Bessemer Medallist of the Iron and Steel Institute, an honorary member of both the Institute of British Foundrymen and the Institute of Metals. Professor Portevin has been honoured by numerous universities by the bestowal of the degree of doctor (*honoris causa*). From its inception, he has taken a prominent part in the work of the *Association Technique de Fonderie*, of which he is now *president d'honneur*. His researches have embraced all the commercial alloys, and his work in conjunction with Cymboliste using brittle lacquers for studying the distribution of stress in metal under load is now a classic.

[Of Professor Portevin's colleague in the preparation of this Paper, no biographical details are available at the time of going to Press.—EDITOR.]

Even in the absence of any exterior force, castings—like all metallic components that have been subjected to mechanical, thermal or chemical treatment (which treatment is never truly homogeneous)—contain residual stresses. Stresses which are revealed by subsequent operations are sometimes called "latent stresses." This term, however, is a pleonasm, since stresses of any kind are hidden. Often, the stresses are called "internal tensions," which is doubly unsuitable, for on the one hand they are at the same time both tensions and compressions and on the other hand they are necessarily internal. It is obvious that they react to conditions defining the internal elastic equilibrium of the solid and at any point are of a magnitude below the actual elastic limit.

These stresses and their effect can be isolated and measured by a number of normal procedures, which are dealt with in the Paper. These depend on factors, the examination of which leads to the development of measures to take either to avoid risks, or to make the effects of the stresses favourable. From this premise, the Paper is divided into four parts: (1) *Procedures for revealing, measuring and classifying the presence or state of residual stresses, their distribution and intensity;* (2) *factors promoting the origination and modification of the state of stress;* (3) *influence of stresses on the existence, behaviour, and use of metallic components; and* (4) *results which apply to castings.*

"Les contraintes latentes ou tensions internes dans les pièces de Fonderie," par le Professeur A. Portevin (membre honoraire de l'Institut des Fondeurs Britanniques). (Mémoire d'échange de l'Association Technique de Fonderie).

Comme toutes les pièces métalliques ayant subi un traitement mécanique, thermique ou chimique, traitement qui n'est jamais rigoureusement homogène, le moulage des pièces de fonderie entraine, en l'absence de tout effort extérieur, des contraintes résiduelles. *C'est un résidu provenant d'opérations antérieures à l'état actuel, parfois appelé "contraintes latentes," ce qui est un pléonasme, puisque les contraintes de toute nature sont cachées et souvent appelées "tensions internes" ce qui est doublement impropre, car d'une part ce sont à la fois des tensions et des compressions et d'autre part elles sont nécessairement internes car on ne voit pas comment elles pourraient être externes. Elles obéissent aux conditions d'assurer l'équilibre élastique interne du solide et d'être en chaque point inférieures à la limite élastique actuelle; c'est évident.*

Ces contraintes et leurs effets peuvent être qualifiés et mesurés par des procédés

généraux que nous rappelons tout d'abord et qui dépendent de facteurs dont l'examen conduit à les moyens d'action, soit pour éviter leurs dangers, soit pour les rendre favorables. D'où la division de cet exposé en quatre parties : (1) *Procédés de révélation, de mesure et de caractérisation de la présence ou de l'état de contraintes résiduelles dans leur répartition et dans leur intensité;* (2)*Facteurs agissant sur la naissance et la modification de l'état de contrainte;* (3) *Influence des contraintes sur la tenue, le comportement et l'emploi des pièces métalliques; et* (4) *Conséquences en ce qui concerne les moulages.*

" Beanspruchungen und Spannungen in Abgüssen," von Prof. Albert Portevin (Ehrenmitglied) (Austauschvortrag der Association Technique de Fonderie).

Wie alle anderen Metallteile, die einer mechanischen, thermischen oder chemischen Behandlung unterworfen waren (welche natürlich auch niemals wirklich gleichmässig ist) weisen auch Gussteile, selbst bei Abwesenheit von äusserlich einwirkenden Kräften, im Innern verbleibende Spannungen auf. Diese sind ein Uberrest von Vorgängen die dem jetzigen Zustande vorausgingen. Sie werden manchmal " latente Spannungen " genannt, was ein Uberfluss an Worten ist, denn Spannungen aller Art sind verborgen und wenn man manchmal von " inneren Spannungen " spricht, so ist das noch weniger richtig, denn es sind einerseits gleichzeitig Spannungen und Pressungen vorhanden und andererseits sind diese notwendigerweise " innere." Es ist klar, dass diese dem im festen Zustande herrschenden inneren elastichen Gleichgewicht unterliegen und dass ihre Grössenordnung an jedem Punkte unterhalb der tatsächlichen Elastizitätsgrenze liegt. Diese Spannungen und ihre Auswirkungen können festgestellt und gemessen werden und zu diesem Zwecke können zahlreiche gewöhnliche Methoden verwendet werden, die in diesem Vortrage besprochen werden. Diese hängen von Umständen ab, deren Untersuchung dazu führt, Massnahmen zu ergreifen, die Gefahren der Umstände zu vermeiden oder ihre Auswirkungen günstiger zu gestalten. Von diesen Voraussetzungen ausgehend, ist der Vortrag in 4 Teile geteilt: (1) *Methoden zur Aufzeigung, Messung und Kennzeichnung des Vorhandenseins von Spannungen oder des Zustandes von verbleibenden Spannungen, deren Verteilung und Intensität.* (2) *Umstände welche zur Entstehung und zur Abänderung des Spannungszustandes führen.* (3) *Einfluss von Spannungen auf das Aussehen, Verhalten und die Anwendung von Metallteilen, und* (4) *Schlussfolgerungen, welche sich auf Gussteile beziehen.*

Paper No. 1121: **" Influence of Grain Size on the Structure, Pressure-tightness and Tensile Properties of Sand-cast Bronzes and Gunmetals," by A. Cibula, M.A., A.I.M. (Sponsored by the British Non-Ferrous Metals Research Association).**

MR. A. CIBULA is an investigator at the laboratories of the British Non-ferrous Metals Research Association in London. He studied at Cambridge University from 1940-42 and 1946-47, where he obtained a first class Natural Science Tripos, part II, Metallurgy, and his M.A. degree in 1947. From 1942 to 46 he was assistant to the works metallurgist at Standard Telephones & Cables, Limited, North Woolwich, London. It was in 1947 that he joined the BNFMRA staff.

The relation between grain size and properties has been studied, using grain refiners developed in previous work. Iron or cobalt boride, or zirconium carbide or nitride, were added to gunmetals containing from 2 to 14 per cent. tin, 2 to 5 per cent. zinc, and 0 to 5 per cent lead, and to bronzes containing 10 or 20 per cent. lead. The following castings were poured at from 1,040 to 1,180 deg. C.: (a) DTD bars; (b) 5-in. dia. discs, with central bosses; (c) plates 1 in. thick, with ribs on both faces; (d) bars 2¼ in. dia. For comparison, alloys were also cast without grain refiners.

Intergranular films of tin-rich eutectoid were more pronounced in the grain-refined castings, but could be eliminated by restricting the tin content to less than 8 per cent. Large intergranular particles of lead in the bearing alloys were also more numerous in the fine-grained castings. In both well-fed and poorly-fed castings, the total porosity was least in alloys of finest grain size. In castings with columnar structures, however, shrinkage porosity tended to concentrate at the centre-line, leaving the skin of the casting sound, whereas in the fine-grained castings porosity was dispersed, leaving little or no sound skin, and largely occurred in layers perpendicular to the direction of feeding. Because of their unfavourable distribution of porosity, grain-refined castings had much poorer pressure-tightness and, generally, mechanical properties.

Equiaxial structures produced by the use of a low casting temperature instead of a grain refiner were associated with similarly-poor pressure-tightness. For each type of casting there was a critical pouring temperature at which the macro-

structure changed from columnar to equiaxial, accompanied by a dispersion of shrinkage porosity, and satisfactory properties were obtained only with higher casting temperatures.

The results suggest that the mode of solidification of bronze and gunmetal castings varies considerably with pouring conditions. Solidification in alloys cast at high temperatures without a grain refiner proceeds largely by skin-growth, whereas when grain refiners are introduced or the metal is cast at a low temperature, equiaxial grains are nucleated throughout the casting and "pasty" solidification occurs.

"Influence de la dimension des grains sur la structure, l'étanchéité à la pression, et les caractéristiques mécaniques de pièces de bronze coulées au sable," par A. Cibula, M.A., A.I.M. (Mémoire de la British Non-Ferrous Metals Research Association).

La recherche de l'influence de la dimension des grains sur les propriétés des métaux coulés, fut entreprise en utilisant des affineurs de grain étudiés au cours de travaux précédents. On introduisit du borure de fer ou de cobalt, ou du carbure ou nitrure de zirconium dans des bronzes contenant entre 2 et 14 % d'étain, entre 2 et 5% zinc et entre 0 et 5% de plomb, de même qu'à des bronzes contenant entre 10 et 20% de plomb. Les pièces suivantes furent coulées à des températures variant de 1040 à 1180° centigrade : (a) éprouvettes DTD; (b) disques de 127 mm. de diamètre avec un bossage central; (c) plaques de 25 mm. d'épaisseur avec des nervures de chaque côté; (d) éprouvettes de 57 mm. de diamètre. Des pièces analogues furent coulées également avec des alliages non affinés afin d'établir des comparaisons.

La présence de couches d'eutectoide riche en étain fut plus accentuée dans les pièces affinées, mais elles purent être éliminés en diminuant la teneur en étain audessous de 8%. Des globules de plomb furent aussi plus abondants dans les alliages affinés de palier. Le pourcentage de porosités fut moindre dans les pièces affinées quelles que soient les dimensions de l'attaque. Cependant les porosités de contraction eurent tendance à se concentrer au centre des pièces non affinées, les parois restant saines, alors que les pièces de métal affiné présentèrent des porosités diffuses, généralement orientées dans une direction perpendiculaire à l'alimentation. En raison de la disposition irrégulière des porosités, les pièces affinées résistèrent moins bien aux essais d'étanchéité et leurs caractéristiques mécaniques furent inférieures.

En coulant à basse température, on obtint des structures analogues à celles des pièces affinées avec des caractéristiques d'essais d'étanchéité comparables. Il existe, pour chaque type de pièce, une température de coulée critique, à laquelle se produit une transformation de structure entraînant une diffusion des porosités de contraction. Des propriétés satisfaisantes ne furent obtenues qu'avec des températures de coulée assez élevées.

Les résultats semblent indiquer que le mode de solidification des bronzes dépend dans une large mesure des conditions de coulée. La solidification des alliages non affinés coulés à haute température semble s'effectuer par croissance de la paroi extérieure des pièces, alors que dans le cas d'alliages non affinés coulés à basse température, ou d'alliages affinés, les pièces se solidifient "pateusement" par formation simultanée de grains au travers de toute la masse.

"Einfluss der Korngrösse auf Gefüge, Druck- und Zerreiss-festigkeit von sandgegossenen Bronzen und Rotgusslegierungen"

von A. Cibula, M.A., A.I.M. (Vortrag der British Non-Ferrous Metals Research Association)

Unter Benützung von Kornverfeinerungsmitteln, die in früheren Arbeiten entwickelt worden waren, wurde die Beziehung zwischen Korngrösse und Eigenschaften untersucht. Eisen-oder Kobaltborid oder Zirkoniumkarbid oder-nitrid wurden zu Rotguss mit 2-14% Zinn, 2-5% Zink und bis zu 5% Blei zugesetzt, ebenso zu Bleibronzen mit 10-20% Blei. Aus diesen Legierungen wurden durch Giessen bei 1040 bis 1180° C. Abgüsse wie folgt hergestellt: a) Zerreisstäbe nach Air Ministry Norm; b) Scheiben von 12.5 cm Durchmesser mit Mittelnabe; c) 2.5 cm dicke Platten mit Rippen an beiden Flächen; Rundstäbe mit 5.5 cm Durchmesser. Für Vergleichszwecke wurden diese Legierungen auch ohne Kornverfeinerungsmittel vergossen.

In der Kristallstruktur sichtbare Filme von zinnreichem Eutektoid waren in den nach Kornverfeinerung gegossenen Abgüssen mehr ausgesprochen, konnten jedoch durch Beschränkung des Zinngehaltes auf nicht mehr als 8% vermieden werden. Grosse Einlagerungen von Bleiteilchen in Lagermetallen waren auch häufiger in kornverfeinerten Legierungen. Sowohl in den reichlich als auch in den ungenügend mit Steigern versehenen Abgüssen war die Gesamtporosität am geringsten in Legierungen mit der kleinsten Korngrösse. In Abgüssen mit säulenförmigem Kristallgefüge zeigten sich jedoch Lunkerungen längs der Mittellinie, wobei die Aussenschichten des Abgusses dicht waren, wogegen Abgüsse in kornverfeinerten Legierungen weit verteilte Porosität aufwiesen, wobei die Aussenschicht mehr oder weniger undicht war und die Porosität hauptsächlich in Lagen senkrecht zur Richtung des Metalleinlaufes auftrat. Wegen ihrer ungünstigen Verteilung der Porosität waren kornverfeinerte Legierungen weniger druckfest und wiesen niedrigere mechanische Prüfwerte auf.

Gleichachsige Strukturen die durch niedrige Gusstemperaturen hervorgerufen waren wenn keine Kornverfeinerungsmittel angewendet wurden, waren gleicherweise mit schlechter Druckfestigkeit ausgestattet. Für jede Gussart gab es eine kritische Gusstemperatur bei welcher sich das makroskopische Gefüge von säulenförmiger zu gleichachsiger Struktur veränderte, was mit einer Verbreitung der Lunkerungsstellen verbunden war und es wurden zufriedenstellende Ergebnisse nur dann erhalten, wenn mit höheren Temperaturen vergossen wurde.

Die Ergebnisse weisen darauf hin, dass die Art der Erstarrung von Rotguss und Bronzen beträchtlich mit den Giessbedingungen wechselt. Erstarrung von bei hoher Temperatur ohne Anwendung von Kornverfeinerungsmitteln gegossenen Legierungen schreitet hauptsächlich von der Gusshaut nach innen zu, wogegen bei Anwendung von Kornverfeinerungsmitteln oder wenn bei niedriger Temperatur vergossen wird, gleichachsige Kristallkörner zur Bildung von Erstarrungskernen in allen Teilen des Gusses führen, wodurch "teigartige" Erstarrung erfolgt.

Paper No. 1122: Light Metal Founders'

"Recent Aluminium Casting Developments," by L. Fletcher (Sponsored by the Association, through the Aluminium Development Association).

MR. L. FLETCHER, who presents the Paper on behalf of the Technical Committee (of which he is Chairman) of the Light Metal Founders' Association, has held the post of manager of the Birmingham factory of the Northern Aluminium Company, Limited, since 1937. Mr. Fletcher has been in the aluminium industry for some 36 years and for 30 years has been associated with his present Company. He is vice-chairman of the Light Metal Founders' Association and a governor of the National Foundry College.

This Paper concentrates attention on the effects of two main streams of development: (a) of aluminium alloys having special casting characteristics (b) of certain foundry and fabrication techniques. It is noted that the successful entry of aluminium castings into fields traditionally held by other metals has been based on the adaptability of the metal for sound and economic casting, or for its advantages in fabrication and service—but usually on both factors. The characteristics of the aluminium/10 per cent. magnesium casting alloy LM10 (BS 1490) are described in view of its emergence from principally aircraft applications into general use over a considerable range. Case histories illustrate the width and diversity of application for all aluminium castings, and the examples quoted include a number recently made by special techniques or new processes. Emphasis is placed on the flexibility of the gravity-die-casting (permanent-mould casting, in America) process, and on the influence of argon-arc welding developments in facilitating the use of relatively small cast sub-components for assembly into complex and often bulky products difficult or impossible to cast in one piece or to join by any other method.

"Récents développements dans la fonderie de pièces d'Aluminium" (Mémoire de la Light Metal Founders' Association, présenté par la Aluminium Development Association).

Ce mémoire attire l'attention sur l'influence de récents développements dans deux directions principales: (a) alliages d'aluminium ayant des caractéristiques particulières; (b) certaines techniques de fonderie et de manufacture. L'auteur rappelle que le succès de l'aluminium dans des domaines d'application qui par tradition étaient l'apanage d'autres métaux, résulte soit de la souplesse avec laquelle il se prête à la coulée de pièces saines et d'un bon prix de revient, soit des avantages qu'il offre en fabrication ou en service, soit, le plus souvent, de ces deux considérations. Les caractéristiques de l'alliage à 10% de magnésium L.M. 10 (BS 1490) sont décrites en raison de la grande variété de ses applications, à l'origine desquelles on trouve l'industrie aéronautique. Des cas particuliers illustrent l'étendue et la diversité des usages des pièces d'aluminium; certains de ces exemples

se rapportent à des pièces obtenues par de nouvelles techniques et de nouveaux procédés. L'auteur insiste sur les ressources offertes par la coulée en coquille, ainsi que sur les possibilités nouvelles issues des récents développements de la soudure à l'argon: il devient possible d'assembler plusieurs pièces de petites dimensions et faciles à couler, en une structure qu'il serait impossible d'obtenir d'un seul bloc ou de construire par quelqu'autre procédé.

"Neuere Entwicklungen der Aluminiumgusstechnik," von L. Fletcher. (Bericht der Light Metal Founders' Association vorgelegt durch die Aluminium Development Association).

Inhaltsangabe: Der Vortrag lenkt die Aufmerksamkeit auf die Wirkungen zweier Hauptentwicklungsrichtungen: (a) Aluminiumlegierungen mit besonderen giesstechnischen Eigenschaften; (b) besondere Gussverfahren und Fabrikationsmethoden. Es ist bekannt, dass das erfolgreiche Eindringen von Aluminiumguss in Gebiete, welche herkömmlich von anderen Metallen beherrscht wurden, seinen Grund in der Anwendbarkeit des Aluminiums für druckdichte und wirtschaftliche Abgüsse hat oder wegen seiner Vorteile bei der Erzeugung und späteren Verwendung—meistens jedoch aus beiden Gründen gleichzeitig. Die charakteristischen Eigenschaften der Aluminiumlegierung mit 10% Mg (British Standard 1490, L.M. 10) werden im Hinblicke darauf beschrieben, dass diese hauptsächlich im Flugzeugbau angewendete Legierung nun auch in einem beträchtlichen Gebiete allgemeiner Anwendung in Erscheinung tritt. Beschreibungen zeigen die Weite und Vielseitigkeit der Anwendung aller Aluminiumlegierungen auf und die angeführten Beispiele schliessen einige vor kurzem nach speziellen Verfahren oder neuen Methoden hergestellte Gussteile ein. Es wird insbesondere auf die Vielseitigkeit der Verwendung von Kokillengussmethoden hingewiesen und auf den Einfluss der Argonschweissmethoden zur Erleichterung der Verwendung verhältnismässig kleiner gegossener Bestandteile, welche zu komplizierten und oft grossen Stücken zusammengesetzt werden, die an sich nicht oder nur schwierig in einem Stück gegossen oder mittels irgend eines anderen Verfahrens verbunden werden können.

Paper No. 1123: "Metal and Mould Research on Steel Castings." Part I—"Solidification Mechanism," by J. A. Reynolds, B.Sc., Ph.D. and A. Preece, M.Sc., F.I.M. (Member). Part II—"Mould- and Core-bonding Agents," by J. M. Middleton, A.Met., A.I.M. and J. White, D.Sc., Ph.D., F.I.M. (Sponsored by the British Steel Castings Research Association).

Dr. J. White was born at Langholm, Dumfriesshire, and was educated at Langholm Academy, Dumfries Academy, and Glasgow University, where he graduated B.Sc., with first-class honours in Physical Chemistry in 1931. The same year he entered the Royal Technical College, Glasgow with a research scholarship in metallurgy, awarded by the Department of Scientific and Industrial Research, and later became research assistant to Prof. R. Hay in the Metallurgy Department, and then lecturer in metallurgy in the College. In 1934, he was awarded Associateship of the College in Metallurgy and in 1935 the degree of Ph.D. of Glasgow University. In 1939 the Carnegie Gold Medal of the Iron & Steel Institute for Research was conferred on him and he graduated D.Sc. (Glasgow). In 1943 he left Glasgow to become research technologist with General Refractories Limited at Worksop. In 1946, he was appointed lecturer in refractory

The first part of the Paper examines some of the factors controlling shrinkage unsoundness in steel castings. It is shown that thermal-analysis data, obtained either by direct measurement or by simulation techniques, can be applied only to the control of gross shrinkage. Experiments are described which illustrate the usefulness of the volume: surface-area ratio as an aid to establishing directional solidification and so achieving this control. Even when directional freezing is established, however, the properties of cast steel may be influenced by microporosity, the occurrence of which is shown to depend on the crystal structure of the casting. This structure cannot be predicted from thermal-analysis data alone, and experiments are described which illustrate the various additional controlling factors, such as size and orientation of the casting, design and location of the feeder-head, and casting temperature. The examination concludes with an analysis of the relationship between these factors and the soundness and properties of steel castings.

The second part of the Paper opens with a description of tests carried out to determine the mineral classification of a bonding clay. The bonding properties, together with a "life" index of a number of bentonites from a wide variety of sources, are then compared, as also is a number of kaolinitic clays of British origin. While it is shown that the latter have inferior bonding properties as compared with the bentonites, mixtures of the two types of clay are indicated as offering certain advantages. Di-electric-cured and oven-baked resin-bonded cores are then compared, and their relative susceptibilities to moisture pick-up are investigated. The incidence of hot-tearing in steel castings is shown to be influenced, not only by the degree to which the mould is rammed, but also by the type and amount of bond employed in the moulding material.

materials at Sheffield University, and in 1952 was elected a fellow of the Institution of Metallurgists, and in the same year had the title of Reader in Ceramics conferred on him by Sheffield University.

MR. J. M. MIDDLETON is the Senior Investigator of the Foundry Process division of the British Steel Castings Research Association. He was educated at Sheffield University, and became Associate in metallurgy in 1937 and an Associate of the Institute of Metallurgists in 1952. From 1940-47 he was an investigator for the Ministry of Supply on Armament Research. He joined the steel castings division of the British Iron & Steel Research Association in 1947 and transferred on its formation in 1951 to the Research and Development division of the British Steel Founders' Association which is now the British Steel Castings Research Association. His investigations have included original work on hot-tearing in steel castings which has been the subject of published papers in this country and America.

DR. J. A. REYNOLDS was born in 1930. He graduated in metallurgy in 1950 at the University of Durham, King's College, Newcastle-upon-Tyne. In 1953 he was awarded the Ph.D. degree for his research at King's College sponsored by the British Steel Castings Research Association. He was appointed to the staff of the British Steel Castings Research Association in 1953, and in 1955 joined Precision Products (Cumberland) Limited, where he is now engaged on the production of alloy-steel precision castings.

MR. A. PREECE is a Graduate and M.Sc. of the University of Wales, Swansea. From 1927-9 he was assistant metallurgist of the Pressed Steel Company at Cowley. He joined South Wales Siemens Steels Research Association in 1929 as Scientific Officer, and in 1933 became a lecturer and reader in metallurgy at Leeds University. From 1948 to the present time he is Professor of Metallurgy at the University of Durham.

" Etudes métallurgiques de l'Acier, et recherches sur les moules destinés à la coulée de pièces d'acier," Première Partie: " Mécanisme de solidification," par J. A. Reynolds, B.Sc., Ph.D., et A. Preece, M.Sc., F.I.M. (membre de l'Institut des Fondeurs Britanniques). Deuxième Partie: " Moules et Agglomérants," par J. M. Middleton, A.Met., A.I.M., et J. White, D.Sc., Ph.D., F.I.M. (Mémoire de la British Steel Castings Research Association).

La première partie du mémoire étudie les facteurs qui contribuent aux défauts de contraction dans les pièces d'acier. L'auteur montre que les résultats donnés par une analyse thermique faite soit par lecture directe, soit par d'autres procédés, ne peuvent s'appliquer à l'étude de la contraction que dans ses grandes lignes; il en est de même du rapport Volume/Surface, dont l'utilité a été prouvée par des essais décrits dans le mémoire. Cependant, même lorsque les directions principales de solidification ont été bien établies, les propriétés de l'acier coulé peuvent être influencées par des microporosités dont la présence est fonction de la structure cristalline de la pièce. Cette structure ne peut être déterminée par l'analyse thermique uniquement, et des essais ont précisé les autres facteurs qui interviennent : tels sont les dimensions et la forme de la pièce, la forme et la disposition de l'alimentation et la température de coulée. L'examen de ces facteurs a permis d'analyser leur rapport avec les caractéristiques et les propriétés des pièces coulées.

La seconde partie du mémoire donne une description d'essais destinés à déterminer la classification minérale d'un agglomérant argileux. Les propriétés agglomérantes et la durée d'éfficacité de nombreuses argiles colloïdales d'origines diverses sont alors comparées, de même que celles de plusieurs argiles kaoliniques britanniques. Alors que ces dernières présentent des propriétés agglomérantes inférieures à celles des argiles colloïdales, l'auteur montre que leur mélange offre certains avantages. L'agglomération de sables à noyaux au moyen de résines cuites au four, ou traitées di-électriquement est ensuite étudiée, ainsi que la sensibilité à l'humidité de noyaux ainsi préparés. La présence de criques dans les pièces d'acier ne dépend pas seulement de serrage d'un moule, mais aussi de sa composition et en particulier du type et de la quantité d'agglomérant utilisé.

" Untersuchungen über das Verhalten von Metall und Gussform bei Stahlguss "—Teil I. " Der Mechanismus der Erstarrung " von J. A. Reynolds, B.Sc., Ph.D., und A. Preece, M.Sc., F.I.M. (Mitglied). Teil II. " Form-und Kernbindemittel " von J. M. Middleton, A.Met., A.I.M., und J. White, D.Sc., Ph.D., F.I.M. (Vortrag der British Steel Castings Research Association).

Teil I.

Der erste Teil des Vortrages untersucht einige der Einflüsse, welche die Lunkerung in Stahlabgüssen kontrollieren. Es wird gezeigt, dass Wärmeanalysenwerte, die entweder durch direkte Messung oder durch Nachahmungsmethoden erhalten worden sind, nur zur Kontrolle der Grosslunkerung herangezogen werden können. Es werden Versuche beschrieben, welche die Nützlichkeit des Verhältnisses : Volumen zu Oberfläche als Hilfe zur Erzielung gerichteter Erstarrung aufzeigen und so zu deren Kontrolle beitragen. Aber selbst wenn solche gerichtete Erstarrung erzielt wird, sind doch die mechanischen Eigenschaften von Stahlguss durch Mikrolunker beeinflusst und es wird gezeigt, dass deren Auftreten von der Kristallstruktur des Abgusses abhängt. Diese Struktur kann jedoch aus den Wärmeanalysenwerten allein nicht vorausgesagt werden und es werden Versuche beschrieben, welche die verschiedenen zusätzlichen Faktoren illustrieren, welche hier von Einfluss sind, wie Grösse und Stellung des Abgusses, Form und Lage des Eingusstrichters und Giesstemperatur. Die Untersuchung schliesst mit einer Analyse der Beziehungen zwischen diesen Faktoren und den Eigenschaften von Stahlguss sowie dessen Druckdichte.

Teil II.

Die zweite Teil des Vortrages beginnt mit einer Beschreibung von Versuchen, die ausgeführt wurden, um die Einteilung von Bindetonen in Mineralklassen zu

bestimmen. Die Bindeeigenschaften einer Anzahl von Bentoniten von den verschiedensten Fundstätten, zusammen mit einem "Lebensindex" derselben, werden verglichen ebenso eine Anzahl kaolinhältiger Tone britischen Ursprunges. Während gezeigt wird, dass letztere minderwertigere Bindeeigenschaften im Vergleiche mit Bentoniten zeigen, bieten Mischungen der beiden Arten von Bindetonen gewisse Vorteile. Durch Hochfrequenz-Energie oder in Kerntrockenöfen getrocknete Kerne, welche mit polymerisierbaren synthetischen Harzen als Binder hergestellt worden sind, werden sodann verglichen und ihre bezügliche Empfindlichkeit gegen Feuchtigkeitsaufnahme wird untersucht. Es wird schliesslich gezeigt, dass das Vorkommen von Heissrissen bei Stahlabgüssen nicht nur darauf zurückgeführt werden kann, dass die Form zu fest gestampft war, sondern auch durch die Art und die Menge des im Form-materiales verwendeten Bindemittels beeinflusst wird.

Paper No. 1124: "Quality Control in a Large Foundry in the Automotive Industry," by R. Baggio (Italian Exchange Paper).

DR. DOTT. ING. ROMOLO BAGGIO, who is the Author of the official Italian Exchange Paper, was born in Rome in 1891 and studied at the Academy and the School for Artillery and Engineering Practice prior to taking up a military career in the Artillery. After serving in the first world war, he resumed his studies at the Turin Polytechnic, and in 1922 gained a degree in mechanical industrial engineering. He then entered the Artillery Technical Service, in which he served for a number of years in various capacities, including that of head of the Pyrotechnical Testing Commission of Capua (cartridge manufacture) and subsequently at Piacenza arsenal (ordnance and projectile manufacture). After a distinguished military career he left the service with the rank of Major-General of Artillery. Dr. Baggio then studied, and later carried out practical tests with ordnance material, his work being referred to in General Montu's "History of the Italian Artillery," volume XII. In February, 1944, he took up an appointment with the Fiat foundries, in which establishment he is at present discharging the duties of head of the testing department.

The Author discusses the aims of modern quality-control and shows how these no longer concentrate simply on separating defective from sound castings, but provide a means of preventing the production of faulty castings by instituting regular checks and controls at all stages of manufacture. Methods of quality-control, using the most up-to-date techniques suitable for foundry work are reviewed. The controls adopted in the FIAT foundries in Turin are described in detail—applied to the production of iron, malleable iron and light-alloy castings used in automobile construction. The possibilities of using statistical control for quality in foundry practice is also discussed.

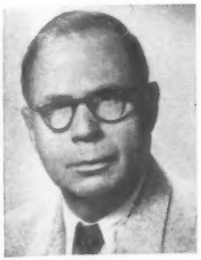
"'Quality Control' dans une grande Fonderie," par Dott. Ing. Romolo Baggio. (Mémoire d'échange du Centro Fonderia Associazione Italiano di Metallurgia).

L'auteur indique les buts du "Quality Control" moderne et montre comment ses méthodes ne tendent plus seulement à la séparation des rebus, mais aussi à leur élimination par la création de vérifications et d'inspections au cours de tous les stades de fabrication. L'auteur fait une description de ces méthodes et des techniques les plus récents appliquées à la fonderie. Il passe en revue les inspections en vigueur dans les fonderies Fiat à Turin, pour la coulée de pièces de fonte, de fonte malléable et d'alliages légers. Il étudie également l'application des méthodes statistiques en fonderie.

"Qualitätskontrolle in einer grossen Giesserei," von Dott. Ing. Romolo Baggio. (Austauschvortrag des Centro Fonderia Associazione Italiano di Metallurgia).

Der Verfasser bespricht die Ziele moderner Qualitätskontrolle und zeigt, wie diese sich nicht mehr einfach darauf konzentrieren, fehlerhafte von guten Gussteilen zu trennen, sondern trachten die Mittel zur Verfügung zu stellen, die Erzeugung fehlerhafter Abgüsse zu verhindern, was durch Kontrollen und Beaufsichtigungen in allen Stufen der Erzeugung ins Werk gesetzt wird. Methoden der Qualitätskontrolle nach den neuesten für Giessereierzeugung anwendbaren Verfahren werden besprochen. Hierauf werden die von der FIAT-Automobilfabrik in Turin in ihrer Giesserei angewandten Uberprüfungsmethoden aufgezählt, die sich auf die Erzeugung von Gusseisen, Temperguss und Leichtmetallguss für den Automobilbau erstrecken. Schliesslich werden die Möglichkeiten statistischer Methoden der Qualitätskontrolle in der Giessereipraxis besprochen.

Paper No. 1125: **"Chemical Reactions in the Cupola," by Dr. Ing. G. A. H. Jungbluth and K. Stockkamp (German Exchange Paper).**



DR. G. A. H. JUNGBLUTH, joint Author of the Exchange Paper from the German Foundry Association was born at Dusseldorf in 1894. He studied metallurgy at the technical university college, Aix-la-Chapelle from 1913 to 1920 and gained the diploma. Then followed a two-year period as assistant to Dr. Oberhoffer at the Metallurgical Institute of this college, after which he gained a doctor-engineers degree. From 1922 to 1943 he held the position of engineer at the Krupp Iron Foundry Works. He was honorary professor at the college at Aix-la-Chapelle from 1941 to 1943, and for the past twelve years has been professor of mechanical technology and testing of materials at the technical university college Friderician at Karlsruhe.

MR. KARL STOCKKAMP, joint Author of the Exchange Paper from the German Foundry Association, was born at Dortmund-Lütgendortmund in 1903. He was educated at Bochum-Langendreher and matriculated in 1923. From 1923 to 1928 he studied metallurgy at the mining college at Clausthal, where he gained the diploma. Mr. Stockkamp was engineer at Buderus Iron Works, Wetzler, from 1929 to 1934, a position he relinquished on being appointed director of the municipal works at

A theoretical study of the chemical reactions in the cupola leads to the conclusion that with increasing temperature in the reaction zone, e.g., through the employment of hot blast, a reduction of iron oxide, a reduction of silica to silicon, a certain degree of reduction of manganese oxide under suitable conditions, a transfer of phosphorus from the charge to the iron and a reduction in the sulphur content of the iron will all take place when the cupola is operated with an acid slag.

A large number of trials have been undertaken on a hot-blast cupola of diameter 600 mm. (24 in.) at the tuyeres which was operated with coke additions of 9, 11 and 13 per cent. at blast temperatures of 20, 300, 400, and 500 deg. C., in order to test these conclusions under the different conditions possible in the hot-blast cupola. These trials showed :—(1) That, owing to the higher combustion temperature brought about by the employment of hot blast, the temperature of the iron rises, although the equilibrium of carbon combustion to CO_2 and CO shifts, according to the position of the Boudouard Curve, towards the CO side, and therefore brings about a diminution in efficiency of fuel utilization in the reaction zone. (2) That, following thermodynamic equilibrium, a lowering of the FeO content of the slag is caused by increased temperature. (3) That as shown by the reaction $SiO_2 + 2C \rightleftharpoons Si + 2CO$, higher temperatures do indeed cause a reduction of the SiO_2 in the slag to silicon, and so also does an increase in the coke percentage. This result is brought about when the temperature is increased at a constant coke rate, largely by the strongly reducing atmosphere of the cupola gases caused by the equilibrium of the carbon combustion shifting over towards the CO side. (4) That a manganese reduction was not obtained during the trials, but that no oxidation of manganese occurred, either, a result which was evidently connected with the manganese and silicon contents of the melted metal. (5) That the phosphorus was fully absorbed by the metal during melting. (6) That despite the acid character of the slag a desulphurization of the iron by the slag was obtained at high temperatures.

"Les réactions du cubilot," par Monsieur le Professeur Dr.-Ing. G. A. H. Jungbluth et K. Stockkamp. (Mémoire d'échange du Verein Deutscher Giessereifachleute).

Une étude théorique des réactions chimiques dans le cubilot conduit à la conclusion que, lorsque le cubilot contient un laitier acide, il se produit en raison de l'élévation de la température dans la zone de réaction due au soufflage à chaud, une réduction de l'oxyde de fer, une réduction de la silice en silicium, dans une certaine mesure et dans certaines conditions, une réduction de l'oxyde de manganèse, une diminution de la teneur en soufre de la fonte et un transfer de phosphore de la charge à la fonte.

Un grand nombre d'essais furent entrepris sur un cubilot de 600 mm de diamètre au droit des tuyères, avec des additions de coke de 9, 11 et 13% et à des températures de soufflage de 20, 300, 400 et 500° centigrades, afin de vérifier les hypothèses théoriques dans ces différentes conditions. Ces essais prouvèrent que :

(1) En raison de l'élévation de la température créée par le soufflage à chaud, la température de la fonte augmente bien que l'équilibre de combustion du carbone en CO et CO_2 se déplace, selon la position de la courbe de Boudouard, du coté du CO, ce qui entraîne une diminution du rendement du combustible dans la zone de la réaction.

(2) En raison de l'équilibre thermodynamique, l'élévation de la température entraîne un abaissement de la teneur en FeO du laitier.

(3) Ainsi que le montre la réction $SiO_2 + 2C \rightleftharpoons Si + 2CO$, l'élévation de la température s'accompagne d'une réduction de SiO_2 en silice dans le laitier; une augmentation du pourcentage de coke produit un effet similaire. Ceci résulte en grande partie du déplacement vers le CO de l'équilibre de combustion du carbone, ce qui augmente le pouvoir réducteur des gaz du cubilot lorsque la température s'élève pour un pourcentage constant de coke.

(4) Il ne se produit ni réduction ni oxydation du manganèse, constatation qu'il faut évidemment associer avec la teneur en manganèse et silicium du métal en fusion.

Wetzlar. During the second world war he served as a lieutenant of engineers from 1942 to 1945, and was a prisoner-of-war and internee from 1945 to 1948. Since 1948 Mr. Stockkamp has held the position of manager of the energy-economy and metallurgical department at Buderus Iron Works.

(5) *Le phosphore est entièrement absorbé par le métal pendant la fusion.*
(6) *Une désulfurisation de la fonte par le laitier est obtenue à haute température malgré le caractère acide du laitier.*

"Die Reaktionen im Kupolofen," von Prof. Dr. -Ing. G. A. H. Jungbluth und K. Stockkamp. (Austauschvortrag des Vereines Deutscher Giessereifachleute).

Eine theoretische Studie über die chemischen Reaktionen im Kupolofen führte zu dem Schluss, dass mit einer Erhöhung der Temperaturen im Reaktionsbereich des Kupolofens, z. B. durch Heisswind, eine Reduktion des Eisenoxyduls, eine Reduktion der Kieselsäure zu Silizium, unter Umständen eine gewisse Reduktion des Manganoxyduls, ein Übertritt des Phosphors aus der Beschickung in das Eisen, eine Verminderung des Schwefelgehaltes des Eisens auch bei Schmelzen mit saurer Schlacke stattfinden muss.

Anhand einer grösseren Serie von Versuchen an einen Heisswindkupolofen mit einem Durchmesser von 600 mm. in der Düsenebene wurden bei Koksätzen von 9, 11 und 13% und bei Windtemperaturen von 20, 300, 400 und 500° C. die im ersten Teil der vorliegenden Arbeit dargestellten Überlegungen über die im Heisswindkupolofen möglichen Reaktionen experimentell nachgeprüft. Dabei ergab sich: (1) dass sich infolge der höheren Verbrennungstemperaturen durch der Heisswind die Eisentemperaturen erhöhen, obwohl das Gleichgewicht der Kohlenstoffverbrennung zu CO_2 und CO sich entsprechend dem Verlauf der Boudouard'schen Kurve nach der CO-Seite verschiebt und damit eine verminderte Brennstoffausnutzung im Reaktionsbereich eintritt; (2) dass analog den thermodynamischen Reaktionsgleichungen durch die höhere Temperatur eine Verminderung des FeO-Gehaltes der Schlacke erfolgt; (3) dass gemäss dem Reaktionsablauf $SiO_2 + 2C \rightleftharpoons Si + 2CO$ mit wachsender Temperatur eine Reduktion des Siliziums aus der Kieselsäure der Schlacke geschieht, und zwar umso früher, je höher der Koksatz ist. Diese Erscheinung ist sowohl eine Folge des höheren Wärmeangebots bei steigenden Koksätzen, als auch einer stärker reduzierenden Atmosphäre des Kupolofengases durch Verschiebung des Gleichgewichts der Kohlenstoffverbrennung nach der CO-Seite hin; (4) dass eine Manganreduktion bei den Versuchen nicht feststellbar war, dass aber auch kein Abbrand an Mangan eintritt, eine Erscheinung, die offenbar auf Beziehungen zwischen dem Si-und Mn-Gehalt der Schmelzen beruhen; (5) dass der Phosphor bei den Schmelzen völlig ins Eisen übergeht; (6) dass trotz des sauren Charakters der Schlacke eine Entschwefelung des Eisens durch die Schlacke aufgrund der höheren Temperaturen im Ofen erfolgt.

Paper No. 1126: "Comparative Study of Melting Furnaces for Grey-iron Foundries," by Dr. Borut Marincek (Exchange Paper from Swiss Foundrymen's Association).

Dr. Borut Marincek, who is the Author of the official Swiss Exchange Paper was born at Trieste in 1915 and educated at Celje, Yugoslavia. After matriculating in 1933 he studied chemistry at the Technical University, Ljubljana, Yugoslavia and gained a diploma in 1937. In the following year he

The continuous increase in coal prices in comparison with the price of electricity, and the constantly higher requirements for the quality of the melted cast-iron justify the comparative review of melting furnaces in the iron foundry. This is particularly the case because of the probability, that also in future the calorific output of coal will become more expensive in proportion to the electrical calory. For this reason, the cold-blast cupola, the hot-blast cupola, the electric-arc furnace and induction furnace have been discussed and compared.

Neither the variety of the method of working of these furnaces nor the difference in the quality of the liquid cast-iron which has been produced in them, permit a direct and indisputable comparison. Nevertheless, the experiment was undertaken to discover through their advantages and disadvantages some point at which one or the other of the furnaces could come into consideration. In this respect, the principal viewpoint has been how these furnaces can enter into the question as regards quality of the liquid iron, how they function in actual practice and which factors influence them economically.

Even at present—under certain special conditions—especially when great efficiency is required as to the quality of the liquid cast-iron, the induction-furnace can come into favourable consideration for economic reasons, particularly in countries where the relation between the electrical calories and coal calories will be favourable for this furnace at present or in the near future.

did National Service in the army and was subsequently works engineer in Yugoslavia. In February, 1940, he went to Berlin and studied metallurgy at the technical university, Berlin Charlottenburg, where he gained the Dr.-Ing. Diploma. Dr. Marincek removed to Switzerland in 1943 to take up an appointment as technical manager at the pig-iron works of Roll's Iron Works, at Gerlafingen and was responsible for the increase in slag-wool production. From 1950 to 1954 he held the position of foundry manager at this Company's works at Choindez near Delemont and during this period was responsible for pig-iron casting, centrifugal-tube casting, and the electro pig-iron works. Since 1954 Dr. Marincek has been working independently in Zurich as an engineer and for the past twelve years has held the position of lecturer in metallurgy at the Federal Technical University, Zurich.

" Etude comparative des fours pour la fusion de la fonte grise," par Dr. Ing. B. Marincek. (Mémoire d'échange du Verband Schweizerisher Eisengiessereien).

L'augmentation continuelle du prix du charbon par rapport à celui de l'électricité, ainsi qu'une constante recherche dans l'amélioration de la qualité de la fonte justifie une étude comparative des fours pour la fusion de la fonte. En effet le prix de la calorie-charbon deviendra, selon toute probabilité, plus élevé que celui de la calorie-électricité. Les mérites relatifs du cubilot avec soufflage à froid ou soufflage à chaud, du four à arc électrique et du four électrique à induction ont donc été étudiés et comparés.

Ni la diversité du fonctionnement de ces fours, ni la différence entre les qualités des fontes produites ne permettent une comparaison directe et indiscutable. Cependant des expériences furent entreprises pour essayer de déterminer leurs avantages et leurs inconvénients, et en particulier d'établir des comparaisons entre la qualité de la fonte, d'étudier leur fonctionnement pratique et de déterminer les facteurs économiques qui les caractérisent.

Dans l'état actuel des choses, si l'on désire une fonte d'excellente qualité, le four à induction semble le plus intéressant du point de vue économique, plus particulièrement dans les pays où la calorie-électricité est, ou sera dans un proche avenir, plus avantageuse que la calorie-charbon.

" Vergleichende Studien über in Eisengiessereien verwendete Schmelzöfen," von Dr. Ing. B. Marincek. (Austauschvortrag des Verbandes Schweizerischer Eisengiessereien).

Die andauernde Steigerung des Kohlenpreises im Vergleich zum Strompreis und andauernd höheren Anforderungen an die Qualität des flüssigen Gusseisens lassen die Durchführung einer vergleichenden Betrachtung der Schmelzöfen der Eisengiesserei rechtfertigen, vor allem weil es wahrscheinlich ist, dass auch in Zukunft die Kohlenkalorie im Vergleich zur Stromkalorie immer teurer wird. Zu diesem Zweck wurden der Kaltwindkupolofen, der Heisswindkupolofen, der elektrische Lichtbogenofen und der Induktions-Schmelzofen als Schmelzofen der Eisengiesserei vergleichend erörtert.

Weder die Verschiedenheit der Arbeitsweise dieser, Oefen noch der Unterschied in der Qualität des darin erzeugten flüssigen Gusseisens lässt einen direkten und eindeutigen Vergleich ohne weiteres zu. Trotzdem wurde der Versuch unternommen, durch die Betrachtung ihrer Vor—und Nachteile Anhaltspunkte dafür zu erhalten, wann der eine oder der andere Ofen in Frage kommen kann. Dabei wurde vor allem erörtert, wie diese Oefen in Bezug auf die Qualität des flüssigen Gusseisens in Frage kommen, wie sie sich als Betriebsöfen auswirken und von welchen Faktoren ihre Wirtschaftlichkeit beeinflusst werden kann.

Heute schon kann unter besonderen Verhältnissen, vor allem, wenn an die Qualität des flüssigen Gusseisens besondere Anforderungen gestellt werden, der Induktionsofen aus wirtschaftlichen Gründen in Betracht kommen, insbesondere in den Ländern, wo sich das Verhältnis zwischen der Stomkalorie und der Kohlenkalorie heute oder in der nächsten Zukunft für diesen Ofen günstig gestaltet.

Paper No. 1127: R. Doat, R. Balon, and

" Metallurgical Studies on the M.B.C. and ADS Cupolas," by Professor A. De Sy, L. Winandy (Belgian Exchange Paper).

Prof. A. De Sy.

Both the cupolas dealt with in this Paper have the common chief objective of the stabilization of the refractory in the melting zone by means of water cooling. This eliminates all subsequent contamination of the slag during melting. In other words, the estimated composition of the slag charged will approximate very closely to that of the slag actually formed. Thus, as is shown in the Paper, the slag, by its composition and volume, can constitute a key to the control of the properties of the iron to be melted. Thereby, it is possible efficiently to control and maintain the iron produced precisely within the desired analytical limits. Obviously, the other factors to be associated with the running of a cupola are taken into consideration, i.e., *the nature of the blast, its temperature, the coke : metal ratio, etc. As well as improvement in the quality of the irons melted, there are outstanding economic advantages—use of cheaper raw materials and a noteworthy reduction in the consumption of refractory and the cost of patching.*

R. DOAT.

R. BALON.

L. WINANDY.

" Resultats d'essais Metallurgiques aux Cubilots M.B.C. et ADS," par Monsieur le Professeur A. De Sy, R. Doat, Ing. Civ. Métall., A.I.Lg., L. Winandy et R. Balon. (Mémoire d'échange de l'Association Technique de Fonderie de Belgique).

Les deux cubilots présentés dans cet article ont pour principale caractéristique commune la stabilisation de l'érosion du réfractaire dans la zone de fusion, par ruissellement d'eau.

Ceci élimine toute contamination ultérieure du laitier ou, en d'autres terms, à l'analyse prévue du laitier chargé, correspond une analyse réelle du laitier formé très voisine.

Or, ainsi qu'il est montré dans ce rapport, le laitier, par son analyse et son volume, constitue le facteur clef de l'élaboration de la fonte au cubilot. On peut dès lors agir efficacement sur cette élaboration et maintenir la fonte produite dans des limites d'analyses très précises, compte tenu évidement des autres facteurs de conduite du cubilot, c'est-à-dire le soufflage, la température du vent, le rapport coke/métal, etc. . . .

A l'amélioration de la qualité des fontes ainsi produites, il faut ajouter deux importants avantages d'ordre économique : l'emploi de matières premières peu coûteuses et la diminution sensible de la consommation de réfractaire et de la main-d'oeuvre d'entretien.

" Ergebnisse metallurgischer Untersuchungen an M.B.C. und ADS Kupolöfen," von Prof. A. De Sy, R. Doat, Ing.Civ.Métall., A.I.Lg., L. Winandy und R. Balon. (Austauschvortrag der Association Technique de Fonderie de Belgique).

Beide in diesem Vortrage besprochenen Kupolöfen haben das gemeinsame Hauptziel der Stabilisierung der feuerfesten Auskleidung in der Schmelzzone mit Hilfe von Wasserkühlung, dies beseitigt alle nachfolgende Verunreinigung der Schlacke während des Schmelzens. Mit anderen Worten, die rechnerisch ermittelte Zusammensetzung des Schlackeneinsatzes wird derjenigen, der tatsächlich gebildeten Schlacke weitgehend nahekommen. In dieser Weise kann die Schlacke, wie im Vortrage gezeigt wird, durch ihre Zusammensetzung und ihren Rauminhalt einen Schlüssel zur Kontrolle der Eigenschaften des zu schmelzenden Eisens bilden. Dies macht es möglich das erschmolzene Eisen wirksam zu kontrollieren und es genau innerhalb der gewünschten analytischen Grenzen beizubehalten. Natürlich werden auch die anderen Faktoren, die mit dem Kupolofenbetriebe in Zusammenhang stehen, wie Wind, Temperatur, Kokssatz u.s.w. in Betracht gezogen, Abgesehen von Verbesserungen der Güte des erschmolzenen Eisens, ergeben sich bedeutende wirtschaftliche Vorteile—Verwendung billigerer Rohstoffe, und die bemerkenswerte Herabsetzung des Verbrauches feuerfester Materialien, sowie der Erniedrigung der Kosten des Ausflickens.

PROFESSOR ALBERT DE SY is one of the co-authors of the Belgian Exchange Paper. He was educated at Ghent University, where he graduated in 1933 with the diplôma ingénieur civil des mines. From 1933 to 1935 Professor De Sy had practical experience in the metallurgical industry, and in the latter year returned to the University of Ghent as a lecturer. Since 1940 he has been a professor of metallurgy at the University and director of the metallurgical and metallographic laboratory. He is a consultant to the C.N.R.M. (Hainaut) and is a member of the Iron and Steel Institute, the American Foundrymen's Society, as well as of the Belgian Foundrymen's Association.

ROBERT DOAT is one of four authors of the Belgian Exchange Paper on "Results of Metallurgical Studies on the B.M.C. and ADS Cupolas." Mr. Doat is a director of the Compagnie Générale des Conduites d'Eau at Liège. He is a member of Council of the Belgian Foundrymen's Association and holds the diplôma of Ingénieur Civil Métallurgiste, Université de Liège.

The third co-author of the Belgian Exchange Paper is ROGER BALON, who is an engineer at the Compagnie Générale, des Conduites d'Eau at Liège, where he is attached to the department dealing with metallurgical installations. Mr. Balon, who is Secretary of the technical committee of the Belgian Foundrymen's Association, holds the diplôma of Ingénieur techn. I.G.Lg.

LUCIEN WINANDY, who is also an engineer at the Compagnie Générale des Conduites d'Eau at Liège, is another of the authors of the Belgian Exchange Paper. He is employed in the company's metallurgical research department and holds the diplôma of Ingénieur Civil Chimiste. Université de Liège.

Paper No. 1128: " Behaviour of Moulding Sands at High Temperatures," by W. B. Parkes and R. G. Godding (Sponsored by the British Cast Iron Research Association).

MR. W. B. PARKES, joint Author of the Paper from the British Cast Iron Research Association, joined the Austin Motor Company, Limited, in 1919, where for seventeen years he held positions in the re-

Apparatus has been constructed by means of which it is possible to raise the temperature of a sand test-piece uniformly and rapidly; the maximum rate of heating attained is from room temperature to 1,000 deg. C. in two min. Stress/strain curves have been obtained on the heated sand in apparatus which permits automatic relaxation of the stress immediately maximum stress is reached, by

search department and the iron and steel foundries of that Company. Since 1936 he has been in charge of the sands laboratories of the British Cast Iron Research Association, and has published many papers on sand and sand testing. Mr. Parkes was the author of the Institute's official exchange paper to the International Conference which was held in America in 1952.

which means the brittleness of the material can be shown. The expansion can also be measured.

Tests show that the expansion of sand increases with hardness of ramming and with very hard test-pieces is very nearly equal to that of quartz. The addition of organic materials such as coal-dust and wood-flour has a negligible effect on expansion, except insofar as it affects ease of compaction. Plain sand/clay mixtures have a deformation which at all temperatures up to the initial softening point of the clay is lower than the expansion up to that temperature; they are also brittle. Defects due to expansion are therefore frequent with such mixtures, particularly in green-sand moulds. The increase in maximum stress found when a sand is heated for a long period does not occur when it is heated rapidly and tested immediately the required temperature is reached. The highest "hot-strength" found is only a few per cent. higher than dry-strength at room temperature. The peak "hot-strength" found with conventional methods of heating has no bearing whatsoever on the behaviour of a mould during pouring.

The addition of wood-flour and many fibrous materials increases deformation slightly and reduces brittleness considerably at all temperatures. Coal-dust has little effect on deformation, but reduces brittleness slightly at temperatures above the softening point of the coal. Test castings show that scabs due to expansion can be eliminated by replacing the quartz by a mineral having an expansion lower than the deformation, or by increasing deformation or reducing brittleness by the addition of wood-flour and fibrous materials. Coal-dust is less effective, but may be adequate under some conditions.

MR. R. G. GODDING, joint Author of the Paper from the British Cast Iron Research Association, was educated at Handsworth Grammar School and later at Birmingham College of Technology. In 1942 he joined the British Cast Iron Research Association as an apprentice and became a permanent member of the sands laboratory. For the past six years he has been a member of the research staff of the Association, working chiefly on the high-temperature properties of moulding sand.

"Comportement des sables de moulage à haute température," par W. B. Parkes (membre de l'Institut des Fondeurs Britanniques) et R. G. Godding (membre adjoint de l'Institut des Fondeurs Britanniques). (Mémoire de la British Cast Iron Research Association).

On a construit un appareil qui permet d'élever rapidement et uniformément la température d'un échantillon de sable : en deux minutes, en partant de la température ambiante, l'échantillon peut être porté à une température de 1,000° centigrades. On a tracé les courbes de la déformation en fonction des efforts dans le sable chauffé, grâce à un appareil qui libère automatiquement la tension engendrée lorsqu'elle atteint sa valeur maximum : de cette façon on connait la fragilité de l'échantillon. La dilatation peut aussi être mesurée.

Les essais montrent que la dilatation du sable croît en fonction du serrage, et des échantillons serrés très dur atteignent des valeurs très voisines de celle du quartz. L'addition de substances organiques telles que poussière de charbon ou sciure de bois n'a qu'un effet très négligeable, si ce n'est dans la mesure où ces substances facilitent le serrage. Des mélanges de sable ordinaire et d'argile présentent une déformation qui, pour des températures inférieures à celle à partir de laquelle l'argile commence à se ramollir, est moindre que la dilatation; de plus ces mélanges sont fragiles. Les défauts dus à la dilatation sont donc fréquents dans les moules de sable vert. L'augmentation de la tension maximum dans le cas d'un chauffage lent, n'existe pas dans le cas d'un chauffage rapide, et d'une mesure effectuée aussitôt que la température voulue est atteinte. La solidité à chaud mesurée est seulement de quelques % plus élevée que celle d'un échantillon sec à température ambiante. Cette solidité à chaud obtenue par un chauffage normal n'à aucun effet sur le comportement du moule pendant la coulée.

L'addition de sciure de bois et de substances fibreuses augmente légèrement la tendance à la déformation, mais réduit considérablement la fragilité à toutes températures. La poussière de charbon a peu d'effet sur la déformation, mais diminue légèrement la fragilité à des températures supérieures à celle à laquelle le charbon commence à se ramollir. Des essais montrent que les défauts de pièces dus à la dilatation peuvent être éliminés soit en remplaçant le quartz par une substance minérale ayant un coefficient de dilatation inférieur à la déformation, soit en augmentant la déformation, soit en réduisant la fragilité par addition de sciure de bois ou de matières fibreuses. La poussière de charbon, bien que moins efficace, peut être indiquée dans certaines circonstances.

"Das Verhalten von Formsanden bei hohen Temperaturen." von W. B. Parkes (Mitglied) und R. G. Godding (Associate) (Vortrag der British Cast Iron Research Association).

Die gemachte Versuchsanordnung ermöglicht es die Temperatur eines Sand-

probestückes schnell und einheitlich zu erhöhen, wobei im günstigsten Falle eine Erhitzung von Raumtemperatur auf 1000° C innerhalb von 2 Minuten erzielt wurde. Es wurden Spannungskurven des erhitzten Sandes mit Hilfe der Apparatur erhalten, welche ein selbsttätiges Nachlassen der Spannung ermöglicht, sobald Höchstspan nung erreicht ist, durch welchen Vorgang die Brüchigkeit des Materiales gezeigt werden kann.

Die Versuche zeigten, dass die Ausdehnung des Sandes mit der Stampfhärte zunimmt und bei sehr dicht gestampften Formsanden nahezu gleich der Ausdehnung von Quarzsand ist. Zusatz organischer Stoffe wie Kohlenstaub und Holzmehl hat nur einen geringfügigen Einfluss auf die Ausdehnung und beeinflusst nur die Leichtigkeit der Verdichtung. Reine Sand-Tonmischungen erleiden eine Formveränderung, welche bei allen Temperaturen bis zum Erweichungspunkte des Tones geringer ist als die bis zu dieser Temperatur eintretende Ausdehnung, auch weisen sie Brüchigkeit auf. Durch Ausdehnung verursachte Fehler sind daher, insbesondere bei Nassgussformen, bei solchen Sandmischungen häufig. Die Zunahme maximaler Spannungen, welche beobachtet wird, wenn ein Sand einer Dauererhitzung unterworfen wird, tritt nicht ein, wenn der Formsand rasch erhitz wird und die Prüfung unmittelbar dann erfolgt, wenn die gewünschte Temperatur erreicht ist. Die höchste bei den Versuchen festgestellte "Hitzefestigkeit" ist nur einige Prozente höher als die Trockenfestigkeit bei Raumtemperatur. Die bei üblichen Methoden der Erhitzung ermittelte höchste "Hitzefestigkeit" steht in keinem wie immer gearteten Zusammenhange mit dem Verhalten der Sandform während des Vergiessens.

Zusatz von Holzmehl oder anderen Faserstoffen erhöht etwas die Formveränderung und verringert bei allen Temperaturen die Brüchigkeit in beträchtlichem Ausmasse. Kohlenstaub hat wenig Einfluss auf Formveränderung, verringert jedoch einigermassen die Brüchigkeit bei Temperaturen oberhalb des Erweichungspunktes der Kohle.

Versuchsabgüsse zeigen, dass Vererzungen infolge von Ausdehnung des Sandes dadurch verhindert werden können, dass der Quarzsand durch ein Mineral ersetzt wird, dessen Ausdehnung geringer ist als die eintretende Formveränderung, oder dass Holzmehl oder Faserstoffe zugesetzt werden, welche die Formveränderung vergrössern oder die Brüchigkeit verringern. Kohlenstaub ist weniger wirksam, mag aber unter gewissen Umständen hinreichend sein.

Paper No. 1129: "Spalling of Green-sand Moulds and its Relation to Casting Defects," by H. Pettersson (Exchange Paper from the Swedish Foundrymen's Association).

MR. HOLGER PETTERSSON, who will present the official Exchange Paper from Sveriges Mekanförbund studied metallurgy at the Royal Institute of Technology, Stockholm, graduating in 1943. After graduation he took up a temporary appointment as assistant at the Technical Institute and later in the same year was appointed to his present position of research engineer at the Swedish Institute for Metal Research. He spent two years doing research work on slag control and

The resistance of a plane mould against the sudden heat effect of the surface of molten metal below the inner mould surface has been studied by ordinary casting experiments or by observation through an open space between the upper and the lower mould-half, when molten steel or cast-iron has given off heat to the observed mould wall without coming into contact with it. The behaviour of the mould has been observed and the influence of the intensity of the heating on the spalling resistance of the mould. The composition of the moulding sand and mould hardness have been studied. Some other experiments of a supplementary nature have also been made.

Coarse-grain sands with wide grain-distribution, a high content of clay (preferably sodium bentonite) and an addition of coal-dust, cereals or sugar are the most important factors pertaining to the composition of the moulding sand that conferred good resistance of the moulds to spalling. At very low moisture contents, the resistance was also very good despite low mechanical strength of the moulds. Otherwise, the magnitude of the original moisture-content had very little influence. An effect of drying was not noted until the moisture content of the heat-affected part of the mould was decreased below about 0.4 per cent. Oven-dried moulds showed a much higher resistance than green-sand moulds. Certain additions, particularly those of an acid character, had a detrimental effect on the resistance of bentonite-bonded moulds. Except at extremely high- and low-hardness values, the resistance increased rapidly with decreased mould hardness. With bentonite-bonded moulds without extra additions, the time before the start of spalling decreased with increasing heating intensity only to a certain limit, whereupon the resistance increased again. Before the moulds failed by flaking, there was a more or less intense "rain" of sand from the heated mould surface.

the constitution of basic open-hearth slags, following which he has been engaged in work on foundry problems particularly in connection with moulding sands, and also on refractories for the metallurgical industry.

After that, pieces of uniform thickness usually scaled away from the exposed mould face. The thickness of these layers, as well as the difference in spalling resistance of moulds between "green" and dry sand are both believed to be connected with the low strength at the transition region between the dried surface layer and the wet sand behind. Exceptionally, the spalling could occur in a different manner. The spalling mechanism is discussed in respect of the temperature gradient that is formed in the mould; the surface layers of different character that are formed due to this gradient; the expansion curve of the sand; and the migration of moisture.

"Affaissement de la surface des moules de sable vert et son influence sur les défauts de Fonderie," par H. Pettersson. (Mémoire d'échange de la Sveriges Mekanförbund).

La résistance d'un moule à l'action de la chaleur brusquement libérée par un métal en fusion a été étudiée soit par des expériences de coulée ordinaires, soit en observant, au travers d'un espace entre les deux parties du moule, la paroi du moule qui a reçu la chaleur de l'acier ou de la fonte sans que ceux-ci aient été à son contact. Le comportement d'un moule et sa résistance à l'affaissement de sa paroi, en fonction de la quantité de chaleur reçue ont été étudiés en même temps que la composition du sable et le degré de serrage du moule. D'autres expériences complémentaires ont également été effectuées.

Des sables à gros grains avec un fort pourcentage d'argile (argile colloïdale de soude de préférence), de la poussière de charbon, de la farine ou du sucre sont les éléments d'un matériau de moulage offrant une bonne résistance à l'affaissement de la paroi. Avec un pourcentage d'humidité très faible cette résistance est encore très bonne malgré la relative fragilité du moule. Autrement dit le degré d'humidité a très peu d'influence. C'est seulement lorsque l'humidité est inférieure à 0.4% dans la partie du moule soumise à la chaleur que son effet se fait sentir. Les moules étuvés présentent une bien meilleure résistance que les moules de sable vert. L'addition de certaines substances, en particulier des substances acides, diminue la résistance des moules contenant de l'argile colloïdale. La résistance est fonction inverse du degré de serrage, sauf dans le cas de dureté de serrage très forte ou très faible. Dans des moules contenant de l'argile colloïdale sans autre addition, le moment où la surface du moule commence à s'affaisser, apparaît plus rapidement lorsque l'intensité de la chaleur augmente; ceci jusqu'à un certain point à partir duquel la résistance à l'affaissement augmente de noveau. Avant que la paroi ne commence à s'écailler, les grains de sable se détachent de la paroi séparément avec une densité plus ou moins forte. Puis des couches de sable d'épaisseur uniforme se séparent du corps du moule. L'épaisseur de ces couches, de même que la différence entre les résistances à l'affaissement des moules en sable vert ou des moules en sable étuvé, semble résulter de la fragilité de la région de transition entre le sable sec de la paroi et le sable humide qui se trouve derrière. Exceptionnellement, l'affaissement peut se produire d'une façon différente. Le mécanisme de cet affaissement est envisagé en fonction du gradient de température du moule, des couches dont le caractère varie en raison de ce gradient, de la dilatation du sable sec du cheminement de l'humidité.

"Das Absplittern von Nassgussformen und dadurch hervorgerufene Gussfehler," von H. Pettersson. (Austauschvortrag des Sveriges Mekanförbund).

Der Widerstand einer ebenen Gussform gegen plötzliche Hitzeeinwirkung der Oberfläche geschmolzenen Metalles unterhalb der inneren Wandung der Gussform wurde mit Hilfe gewöhnlicher Gussversuche untersucht oder durch Beobachtung durch eine zwischen oberer und unterer Gussformhälfte gelassenen Öffnung, nachdem geschmolzener Stahl oder Gusseisen ihre Wärme an die unter Beobachtung stehende Formwandung abgegeben haben, ohne jedoch mit ihr in Berührung gekommen zu sein. Es wurde das Verhalten der Form selbst und der Einfluss der Hitzeintensität auf das Absplittern der Gussform studiert. Zusammensetzung des Formsandes und Härte der damit hergestellten Gussformen wurde untersucht, ferner wurden ergänzende Versuche in anderer Richtung unternommen.

Die wichtigsten Erfordernisse für die Zusammensetzung eines Formsandes, der guten Widerstand der Gussform gegen Absplitterung gewährleisten soll, sind: Grobkörniger Sand mit weiter Korngrössenverteilung, hoher Tongehalt (vorzugs-

weise Natriumbentonit), Zusatz von Kohlenstaub, Getreideschrot oder Zucker. Bei sehr geringem Feuchtigkeitsgehalt war auch der Widerstand sehr gut trotz geringer mechanischer Formfestigkeit, davon abgesehen war das Ausmass des ursprünglichen Feuchtigkeitsgehaltes von untergeordneter Bedeutung. Ein Einfluss von Vortrocknung wurde nicht festgestellt solange der Feuchtigkeitsgehalt des unter Hitzestrahlung stehenden Teiles der Gussform nicht unter 0.4% herunterging. Im Formtrockenofen getrocknete Gussformen zeigten einen weit höheren Widerstand als Nassgussformen. Verschiedene Zusätze, besonders solche mit saurer Reaktion, hatten nachteiligen Einfluss auf den Widerstand von mit Bentonit gebundenen Gussformen.

Bei verminderter Gussformhärte steigerte sich der Widerstand sehr rasch und nur besonders hohe oder besonders niedrige Härtewerte waren mit ungünstigen Ergebnissen in Verbindung zu bringen. Bei Verwendung von mit Bentonit gebundenen Gussformen ohne weitere Zusätze nahm die Zeitspanne bis zum Beginne des Absplitterns bei steigender Hitzeintensität nur bis zu einem gewissen Grenzwert ab, wonach sich der Widerstand wieder erhöhte. Bevor die Gussformen durch Abkrusten unbrauchbar wurden, war ein mehr oder weniger intensiver "Sandregen" bemerkbar, der von der erhitzten Formoberfläche abrann. Nachdem dies geschehen war, lösten sich Stücke von ungefähr gleicher Schichtdicke von der der Hitze ausgesetzten Gussformoberfläche ab. Es wird angenommen, dass die Schichtdicke dieser Lagen als auch das verschiedene Verhalten hinsichtlich Absplitterns der Gussform bei Nassguss-und Trockengussformen in Zusammenhang steht mit der geringen Festigkeit, die in der Übergangszone auftritt, welche die Grenze zwischen der getrockneten Oberflächenschichte und dem nassen Sand dahinter bezeichnet. In Ausnahmsfällen könnte das Absplittern auch aus anderen Gründen erfolgen. Schliesslich wird der Vorgang der Absplitterung besprochen in Hinblick auf in der Gussform auftretendes Temperaturgefälle, in Hinblick auf Oberflächenschichten verschiedenen Charakters, welche sich als Folge des Temperaturgefälles ausbilden, in Hinblick auf die Ausdehnungskurve des Formsandes und der Wanderung der Feuchtigkeit in der Gussform.

Paper No. 1130: "Effect of Mould Material on the Solidification Rate of Cast Metals" (Combined Report of Sub-committees T.S. 21, 33 and 46).

CONSTITUTION OF THE SUB-COMMITTEES: J. Hird (chairman of T.S.46 and T.S.33 and a member of T.S.21); D. W. Berridge (T.S.46); J. T. Berry, B.Sc., Ph.D. (T.S.46); L. W. Bolton, A.M.I.Mech.E., F.I.M. (chairman of T.S.21 and a member of T.S.33); E. R. Dunning (T.S.21 and T.S.33;) J. H. Gittus, B.Sc. (T.S.33 and T.S.46); S. J. Heritage (T.S.46); V. Kondic, B.Sc., Ph.D., (T.S.21, T.S.33 and T.S.46); R. Lee, A.Met., F.I.M. (T.S.46); G. Martin, B.Sc., Ph.D., G.I.Mech.E. (T.S.33, T.S.46); P. Robinson (T.S.21); R. W. Ruddle, M.A., F.I.M. (T.S.21, T.S.33, and T.S.46); P. A. Russell, B.Sc.Met., F.I.M. (T.S.21 and T.S.33); G. R Shotton (T.S.21, T.S.33, and T.S.46); D. Snelson, B.Sc. (T.S.21); A. Tipper, M.Sc., F.I.M. (T.S.21, T.S.33 and T.S.46); G. Lambert (T.S.21, T.S.33, and T.S.46), secretary.

The first committee to investigate this work started in 1947 with the following terms of reference:—"To determine the influence of mould materials on the rate of solidification of cast iron by the interrupted-freezing method." The Metallurgy Department of Birmingham University, to whom grateful acknowledgment is made, co-operated with this sub-committee and have done so throughout this and subsequent work. It was thought that the rate of solidification of a casting could be conveniently defined as the speed of movement of the solid/liquid metal interface away from a mould wall, and that by "slushing" a casting it would be possible to study this movement. The slush-casting method consists of filling a mould with molten metal and, after a pre-determined time, breaking the mould open at the bottom of the mould cavity or inverting the mould, thus allowing that part of the metal still liquid to flow out. The shell or crust thus formed is then weighed or measured, the assumption being that the greater the cooling power of the mould material used, the greater the shell thickness for a given time of standing before slushing. The conclusions drawn from experiments with this method are:—(a) That it is insufficiently sensitive to determine the difference in cooling power of different types of sand and (b) that in all pure metals, or alloys freezing at a constant temperature, there exists a zone of partial solidification between the all-liquid and all-solid zones and this makes the definition of the solidification rate difficult. The next approach to the work was to investigate the suitability of the pyrometric method for investigating the rate of solidification of cast metals. This work was done by sub-committee T.S. 33 and consists of placing one or more thermocouples in selected positions in the mould cavity or mould material or both, and recording the temperature changes with a one-second-response temperature recorder, or high-speed galvanometer, from the moment of pouring the metal into the mould until solidification is complete. This method proved quite successful, provided certain precautions were taken to prevent variations in results. The main precautions to be taken are: (a) sand density and moisture content must be controlled; (b) casting size must be suitable; and (c) pouring temperature and casting speed must be controlled and splashes eliminated.

The main investigation was carried out by sub-committee T.S.46 using this method and, by standardizing all variables, very good reproducibility was obtained. Some of the general conclusions to be drawn from this work are: (a) That the coarser the sand the greater its cooling power at a given ramming density; (b) the harder a mould is rammed the greater its cooling power at a given ramming density, other variables being the same; (c) the higher the moisture content of a sand the greater its cooling power when all other variables are equal; and (d) the presence of coal-dust causes some increase in the cooling power of the mould in the case of casting sections up to 1½-in. thick. This work was carried out with natural and synthetic sands generally used in the British Isles. Other types of sand and moulding materials have still to be investigated.

" Influence de la composition du moule sur la vitesse de solidification de métaux coulés " (Mémoire de la Sous-Commission T.S.46 du Conseil Technique de l'Institut des Fondeurs Britanniques).

Résumé. *La première Sous-Commission chargée de ces recherches se mit au travail en 1947 : elle devait étudier " L'Influence de la composition des moules sur la vitesse de solidification de la fonte en utilisant la méthode de solidification limitée." Le Département de Métallurgie de l'Université de Birmingham, auquel un hommage est rendu dans le mémoire, a travaillé avec la Sous-Commission tant pour ces études préliminaires que pour celles qui les ont suivies. On pensait que la vitesse de solidification d'une pièce pouvait être définie comme la vitesse de déplacement, à partir des parois du moule, de la surface séparant le métal solide du métal liquide, et qu'en utilisant la méthode de solidification limitée, il serait possible d'étudier ce déplacement. Cette méthode consiste à remplir un moule avec du métal en fusion, et à briser le fond du moule, ou à le retourner pour en extraire le métal encore liquide, à un moment déterminé. La partie solidifiée est alors pesée et mesurée, dans l'hypothèse que le pouvoir de refroidissement du moule est fonction du poids et des dimensions du métal solidifié après un temps donné. Après avoir essayé cette méthode, il a fallu constater que : (a) la méthode n'est pas assez sensible pour établir le pouvoir de refroidissement des différents types de sable utilisés; (b) il existe une zone de solidification partielle entre les zones de solidification et de fusion totale, dans le cas de tous les métaux purs et des alliages se solidifiant à température constante, ce qui complique la notion de vitesse de solidification.*

Le méthode pyrométrique fut alors essayée par la Sous-Commission T.S. 33. Elle consiste à disposer un ou plusieurs couples thermoélectriques à des endroits bien déterminés de la cavité du moule ou de ses parois, ou à la fois dans la cavité et dans les parois, et à étudier les variations de température avec un enregistreur, ou un galvanomètre à faible inertie, entre le moment de la coulée et celui de la solidification complète. Ce procédé s'est révélé excellent, à condition que les précautions suivantes soient scrupuleusement observées pour éviter une dispersion des lectures : (a) la compacité du sable et son humidité doivent être bien contrôlées; (b) les pièces doivent être d'une dimension appropriée; et (c) la température et la vitesse de coulée doivent être soigneusement observées et les rejaillissements de métal évités. Les recherches basées sur cette méthode furent surtout approfondies par la Sous-Commission T.S. 46, et grâce à une standardisation des variables, les phénomènes purent être très fidèlement reproduits. Les conclusions à tirer de ces travaux sont les suivantes : (a) le pouvoir de refroidissement d'un moule, pour une compacité donnée, est fonction de la grosseur des grains de sable; (b) il est fonction du serrage du sable; (c) il est fonction du degré d'humidité du sable; (d) il augmente quelque peu lorsque le sable contient de la poussière de charbon, ceci pour des épaisseurs allant jusqu'à 38 mm. Les sables naturels et synthétiques généralement utilisés en Grande-Bretagne ont été essayés au cours de ces travaux, mais il reste d'autres sables et matériaux à étudier.

" Einfluss des Formmaterials auf die Erstarrung gegossener Metalle," (Bericht des Unterausschusses T.S.46 des Technischen Komitees).

Inhaltsangabe : Dem ersten Ausschusse der seine Untersuchungen im Jahre 1947 begann. war folgende Aufgabe gestellt worden : " Es ist der Einfluss des Formmaterials auf die Erstarrungsgeschwindigkeit von Gusseisen mit Hilfe der Methode unterbrochener Erstarrung festzustellen." Die Lehrkanzel für Metallurgie der Universität Birmingham, welcher der Dank für die Mitarbeit ausgesprochen wird, hat mit dem Unterausschuss von der ersten Untersuchung

angefangen bis zu allen folgenden zusammengearbeitet. Der Grundgedanke war, dass die Erstarrungsgeschwindigkeit eines Abgusses zweckmässig definiert werden kann als die Geschwindigkeit des Fortschreitens der erstarrt-flüssig Zwischenfläche in der Richtung von der Gussformwand weg gegen das Innere der Gussform, und dass es möglich wäre durch Entfernung des noch nicht erstarrten Metallbreies zu einem gewählten Zeitpunkte dieses Fortschreiten der Erstarrung zu studieren Die Methode besteht daher darin, eine einfache Gussform mit geschmolzenem Metall zu füllen und, nach einer im Voraus gewählten Zeit, entweder die Gussform an der Unterseite aufzubrechen oder die Gussform umzustürzen und so den noch nicht erstarrten Metallbrei auszugiessen. Die übrig bleibende Metallschale oder Metallkruste wird sodann gewogen oder gemessen, wobei angenommen wird, dass die Krustendicke umso grösser ist je grösser die Kühlungswirkung des Formmateriales ist, gleiche Wartezeit vor Ausgiessen des Metallbreies vorausgesetzt. Aus den Versuchsergebnissen nach dieser Methode wurden folgende Schlussfolgerungen gezogen :—(a) Die Methode ist nicht empfindlich genug um den Unterschied in der Kühlungswirkung verschiedener Sandarten festzustellen; und (b) Bei allen reinen Metallen und allen bei bestimmter Temperatur erstarrenden Legierungen tritt eine Zone teilweiser Erstarrung zwischen den vollständig erstarrten und den vollständig flüssigen Zonen ein, was die Bestimmung der Erstarrungsgeschwindigkeit erschwert. Der nächste Schritt war dann, die Eignung der pyrometrischen Methode zur Bestimmung der Erstarrungsgeschwindigkeit gegossener Metalle zu prüfen. Diese Arbeit wurde vom Unterausschuss T.S. 33 durchgeführt und die Methode besteht darin ein oder mehrere Thermoelemente entweder in den Gussformhohlraum oder die umgebende Gussformmasse (oder in beide gleichzeitig) unterzubringen und die auftretenden Temperaturänderungen mit einem auf 1 Sekunde empfindlichen Temperaturregistrierinstrument oder einem hochempfindlichen Galvanometer aufzuzeichnen, beginnend mit dem Augenblick des Gussbeginnes und endigend wenn die Erstarrung vollständig ist. Dieses Verfahren erwies sich als recht erfolgreich, vorausgesetzt, dass gewisse Vorsichtsmassregeln ergriffen wurden um Abweichungen in den Ergebnissen zu verhindern. Die wichtigsten Vorsichtsmassnahmen sind : (a) Sanddichte und Feuchtigkeitsgehalt müssen überwacht werden; (b) Der Abguss muss von geeigneter Grösse sein; und (c) Gusstemperatur und Giessgeschwindigkeit müssen kontrolliert und Metallspritzer vermieden werden.

Die Hauptuntersuchungen nach dieser Methode wurden vom Unterausschuss T.S. 46 durchgeführt und gute Wiederholbarkeit der Ergebnisse wurde durch weitgehende Normung veränderlicher Faktoren erzielt. Einige der allgemeinen Schlussfolgerungen aus diesen Versuchen sind : (a) Je grobkörniger der Formsand ist, desto grösser ist seine Kühlungswirkung bei gleichbleibender Stampfdichte; je härter eine Form gestampft ist, desto grösser ist ihre Kühlwirkung bei gleichbleibender Stampfdichte; (c) Je grösser der Feuchtigkeitsgehalt eines Formsandes ist, desto grösser ist seine Kühlwirkung, vorausgesetzt, dass alle anderen veränderlichen Einflüsse gleich gehalten werden; und (d) die Gegenwart von Kohlenstaub erhöht einigermassen die Kühlwirkung der Gussform im Falle von Abgusswandstärken bis 3.7 cm. Diese Untersuchungen wurden mit den in Grossbritannien üblichen natürlichen und künstlichen Formsanden durchgeführt. Andere Sandarten und Formungsstoffe sind noch zu untersuchen.

Paper No. 1131: "Widmanstatten and other Abnormal Graphite Forms in Cast Iron," by E. Bull Simonsen, and Floyd Brown, D.Sc. (Norwegian Exchange Paper).

E. B. Simonsen.

The appearance and condition of formation of a number of abnormal graphite forms in grey cast iron, associated with impaired mechanical properties, are described. A rationale of these several forms is proposed. First, earlier references in foundry literature to Widmanstätten-type graphite are quoted. Then, the Authors' investigations on castings of 1 to 6 tons are related, though no correlation between metal composition and the occurrence of abnormal graphite was observed. It is postulated that the formation of Widmanstätten-type graphite is not a function of a critical cooling-rate or is it reproducible after heat-treatment.

Investigation of trace elements present along with the abnormal graphite forms led to the suspicion that lead and tin might be causatory features, and experiments proved that in fact Widmanstätten-type graphite was associated with a lead addition to a melt; tin giving a negative result. Other experimental work is

proceeding, but interim conjectures are made as to the possible mechanism of formation of the abnormal structures.

" Widmanstätten et autres formes anormales de Graphite dans la fonte," par E. Bull Simonsen, Mag. Scient., et Floyd Brown, D.Sc. (Mémoire d'échange de la Norges Stoperitekniske Forening).

Le mémoire donne une description de plusieurs formes anormales de graphite dans la fonte grise entraînant une détérioration des propriétés mécaniques, et il analyse les conditions de leur formation. Les auteurs proposent une classification rationnelle de ces différentes formes. Tout d'abord ils font des références à la littérature technique traitant du graphite Widmanstätten. Puis ils relatent les recherches effectuées sur des pièces pesant de une à six tonnes, quoiqu'ils n'aient constaté aucune corrélation entre l'apparition de formes anormales de graphite et la composition de la fonte. Ils considèrent que la formation de graphite Widmanstätten n'est pas fonction de la vitesse de refroidissement ou qu'elle ne peut pas être reproduite après un traitement thermique.

L'analyse des traces de métaux présentes dans des fontes présentant des formes anormales de graphite fit penser que le plomb et l'étain pourraient être à l'origine de ces anomalies, et des expériences prouvèrent que le graphite Widmanstätten est associé avec une addition de plomb dans la fusion; l'action de l'étain par contre n'a pas été démontrée. D'autres travaux sont encore en cours, mais les auteurs proposent une explication provisoire du mécanisme de formation de ces structures graphitiques anormales.

" Widmanstätt'sche und andere ungewöhnliche Grafitformen in Gusseisen," von E. Bull Simonsen, Mag.Scient. und Floyd Brown, D.Sc. (Austauschvortrag der Norges Stoperitekniske Forening).

Das Auftreten und die Bildungsbedingungen einer Anzahl von ungewöhnlichen Grafitformen in Gusseisen, die mit verminderten mechanischen Eigenschaften verbunden sind, werden beschrieben und eine vernünftige Erklärung wird vorgeschlagen. Einleitend werden frühere Hinweise in der Giessereiliteratur erwähnt, die sich auf das Auftreten von Grafit in Widmannstätt'schen Formen beziehen. Hierauf wird über des Verfassers Untersuchungen an Abgüssen von 1 bis 6 Tonnen Gewicht berichtet, obwohl keine gegenseitige Abhängigkeit zwischen Metallzusammensetzung und dem Auftreten ungewöhnlichen Grafites beobachtet werden könnte. Es wird vorausgesetzt, dass bie Bildung von Grafit in Widmannstätt'schen Formen keine Funktion der Abkühlungsgeschwindigkeit sein kann oder dass diese Bildung nach erfolgter Wärmebehandlung wieder hervorgebracht werden könnte.

Untersuchungen hinsichtlich bei Auftreten von ungewöhnlichen Grafitformen gegenwärtiger Spurenelemente führten zur Vermutung, dass Blei und Zinn in ursächlichem Zusammenhange stehen könnten und tatsächlich zeigten Versuche, dass Grafit in Widmannstätt'schen Formen mit Bleizusätzen erzielbar war, während Zinn ein negatives Ergebnis zeitigte. Weitere Versuchsreihen sind in Arbeit, aber vorläufige Vermutungen drücken den möglichen Vorgang der Bildung ungewöhnlicher Grafitstrukturen aus.

Paper No. 1132: " Nomogram for Fairly-hot Non-alloyed Iron Cast in ordinary Dry-sand Moulds," by Sv. Thegel (Exchange Paper from the Danish Foundrymen's Association).

The object of this Paper has been to produce a nomogram between thickness of castings, composition and hardness, available for fairly-hot unalloyed iron cast in ordinary dry-sand moulds. The data are established as a result of testing 50 test-bars each of 20-, 30-, and 40-mm. dia. All 150 bars were ordinary daily control test-pieces. After close consideration of the results and after the coefficient of correlation was determined for a number of various expressions for composition and hardness, it was decided to fix the nomogram between section thickness, ($C + \frac{1}{3} Si$) and ($H - 30\ P$), in which C is the carbon, Si the silicon and P the phosphorus contents, and H the Brinell hardness. By means of the equations determined between ($C + \frac{1}{3} Si$) and ($H - 30\ P$) for the various diameters, three coherent values for ($C + \frac{1}{3} Si$) and ($H - 30\ P$) for each diameter were calculated and the nomogram was constructed. Within the above-mentioned field of utilization of the nomogram

MR. EDGAR BULL SIMONSEN, a member of the Norsk Metallurgisk Selskap, is joint Author of the official Norwegian Exchange Paper. Born at Trondhjem, Norway, in 1923, Mr. Simonsen received his general education in Norway, Italy and Germany. From 1943 to 1951 he studied inorganic chemistry at the University of Oslo and obtained the degree of Mag. Scient. for a thesis on grain boundary cementite in mild steel. After graduation he took up his present position at the Central Institute for Industrial Research. In 1953, under the auspices of the Royal Norwegian Council for Scientific and Industrial Research, Mr. Simonsen came to England where he worked on high-temperature at the Department of Metallurgy at Cambridge University.

MR. FLOYD BROWN, joint Author of the official Norwegian Exchange Paper, studied at the Carnegie Institute of Technology, where he gained the degree of D.Sc., in 1950. Prior to this he was associated with the Metals Research Laboratory, Carnegie Institute of Technology, and since graduating has held research posts at the Massachusetts Institute of Technology and the North Carolina State College. Dr. Brown, who holds an appointment at the Naval Research Laboratory, Washington, was associated with the Institute for Industrial Research, Oslo, during the summer of last year.

MR. SVEND THEGEL, who will present the official Danish Exchange Paper, was born at Skive, Denmark, in 1896. He matriculated in 1913 and later studied at the Royal Technical College, Copenhagen, where he obtained a degree in civil engineering. After completing military service he held various technical appointments. Mr. Thegel joined his present company, Burmeister & Wain, Copenhagen, in 1925, since when he has been attached to the foundries of this firm.

figures for the ($C + \frac{1}{3} Si$), which must be present in the iron in order to get a desired hardness in a given section thickness, can easily and quickly be obtained.

" Abaque relatif a la coulee de la fonte ordinaire a haute température dans des moules de sable sec," par Sv. Thegel. (Memoire d'echange du Stoberiingeniorernes Klub).

Ce mémoire décrit la construction d'un abaque entre l'épaisseur des pièces de fonte ordinaire coulées à haute température dans des moules de sable sec, la composition de la fonte et sa dureté. Les essais préliminaires portèrent sur 150 éprouvettes de contrôle journalier de fonderie : 50 d'entre elles avaient un diamètre de 20 mm., 50 un diamètre de 30 mm., et les 50 dernières un diamètre de 40 mm. Après un examen approfondi des résultats de ces essais, on rechercha un coéfficient de corrélation entre différentes expressions de la composition et de la dureté. Les éléments choisis furent l'épaisseur de la pièce, et les expressions ($C + \frac{1}{3} Si$), et ($H - 30 P$), dans lesquelles C est la teneur en carbone, Si la teneur en silicum, P la teneur en phosphore, et H la dureté Brinell. Des équations furent établies entre ($C + \frac{1}{3} Si$) et ($H - 30 P$) pour chacune des trois séries d'éprouvettes, et l'abaque fut construit à partir des résultats de ces équations. Dans le champ d'utilisation déterminé par le diamètre des éprouvettes, l'abaque permet de trouver la valeur de ($C + \frac{1}{3} Si$) correspondante à la dureté désirée.

" Nomogramm für ziemlich heisses, in Trockensand gegossenes unlegiertes Gusseisen," von Svend Thegel. (Austauschvortrag des Stoberiingeniorernes Klub).

Es wurde versucht, ein Nomogramm zu entwerfen, das für nicht legiertes, ziemlich heisses und in trockene Sandformen vergossenes Gusseisen die Beziehungen zwischen Wandstärke des Gussteiles, Zusammensetzung und Brinellhärte herstellt. Die Unterlagen wurden durch Prüfung von je 50 Probestäben mit 20 bezw. 30 bezw. 40 mm Durchmesser gewonnen, alle 150 Probestäbe stammten von gewöhnlichen täglichen Gussproben. Nach Prüfung der Ergebnisse und Aufstellung eines Koeffizienten für die gegenseitige Abhängigkeit der Werte für Zusammensetzung und Härte, wurde der Entschluss gefasst, ein Nomogramm zu entwerfen, das basiert ist auf: (1) Wandstärke; (2) Gesamtkohlenstoff % plus ein Drittel Silizium % ($C + \frac{1}{3} Si$); und (3) dem Ausdrucke ($H - 30 P$) wobei H die Brinellhärte und P den Phosphorgehalt in % bedeutet. Mit Hilfe der für verschiedene Wandstärken berechneten Werte für ($C + \frac{1}{3} Si$) und ($H - 30 P$) wurde das Nomogramm aufgestellt, das innerhalb der oben angegebenen Grenzen der Brauchbarkeit ein schnelles Ablesen ermöglicht, wie hoch der Wert ($C + \frac{1}{3} Si$) sein muss, um bei gegebener Wandstärke eine gewünschte Härte zu erzielen.

Paper No. 1133: " Moulding in an Indian Foundry," by S. G. Athanikar (Exchange Paper from the Institute of Indian Foundrymen).

MR. S. G. ATHANIKAR, A.M.I.B.F., the Author of this paper, was born and educated in the Bombay State and holds a diploma in foundrywork and metallurgy. He has several years' practical experience

After first reviewing the scope and facilities at the foundries of the Indian Iron & Steel Company, Kulti, the Author gives in detail the procedures adopted for moulding four typical castings of the medium-to-large weight range. In this way, the versatility of the methods—loam moulding, core-assembly, and sectional-moulding—is developed. The descriptions reveal expedients adopted in the Indian foundry, which will be of value to practical foundrymen in other countries.

" Moulage dans une Fonderie Indienne," par S. G. Athanikar (membre adjoint de l'Institut des Fondeurs Britanniques). (Mémoire d'échange de l'Institute of Indian Foundrymen.)

Résumé. *Après avoir donné un aperçu de l'importance et de l'équipement de la Indian Iron & Steel Company, Kulti, l'auteur décrit en détail les procédés utilisés pour le moulage de quatre pièces types de moyennes et grandes dimensions. De cette façon l'on peut se rendre compte de la diversité des méthodes—moulage en terre, assemblage de noyaux, moulage par sections. Cette description fournit des exemples de solutions adoptées par la fonderie indienne, solutions qui pourraient présenter un intérêt pour des fondeurs étrangers.*

as a foundryman and is familiar with a wide range of casting production. He has visited foundries in the U.K. and studied modern production methods of some of the advanced foundries here. At present he holds a responsible position with the Indian Iron & Steel Company, Limited, Kulti, West Bengal, which is one of the largest groups of foundries in India.

" Formverfahren in einer indischen Giesserei," von S. G. Athanikar (Angeschlossenes Mitglied) (Austauschvortrag des Institute of Indian Foundrymen).

Inhaltsangabe: Nach einem Uberblick über den Arbeitsbereich und die Einrichtungen der Giessereien der Indian Iron & Steel Company gibt der Verfasser Einzelheiten der Methoden, die für vier typische mittelgrosse bis schwere Abgüsse verwendet werden. Die Vielseitigkeit der für Formen und Kernmachen notwendigen Improvisationen in dieser indischen Giesserei mag für praktische Giessereifachleute in anderen Ländern von Interesse sein.

Paper No. 1134:

" Jobbing Investment Foundry in South Africa," by J. Steele (South African Branch Exchange Paper).

MR. JOHN STEELE, the 1954-55 President of the South African Branch, who will present the official branch Exchange Paper, was born in 1923 at Wishaw, Scotland. He was educated at Wishaw High School and received his technical education at Stow College of Engineering, Glasgow. For the latter course he was awarded the McInnes-Shaw Prize. In 1944 he was awarded the Surtees Silver Medal by the Scottish Branch of the Institute and two years later obtained his Intermediate Certificate in the City and Guilds examinations. Mr. Steele served his apprenticeship as a moulder with the Clyde Alloy Steel Company, following which he was employed in the iron and non-ferrous foundries of G. & J. Weir, Limited. In 1947 he emigrated to South Africa and after a period of service as a moulder, he entered the laboratory of the South African Iron and Steel Corporation. In 1949 he became foundry manager of the precision casting department of Rely Products, Limited, Johannesburg. Mr. Steele now holds an appointment with Precision Dental Laboratories (Pty.), Limited, Johannesburg, as manager of this Company's new foundry to place on a production basis the lost-wax process of industrial investment casting as developed in the dental laboratory of the firm.

This Paper outlines the establishment of the first industrial investment-casting foundry in South Africa. The period covered is five years, from the initial experimental stage to present-day full production capacity. The early history of the foundry is briefly outlined in the introduction and then the subject matter of the Paper is divided into three sections:—The first section is entitled " process and personnel " a title which is self-explanatory and reviews the investment-process used and personnel employed. To overcome belated overseas delivery periods and economic considerations, certain equipment was constructed and a special procedure adopted. This is dealt with in detail under " procedure " in the second section, and includes:—(1) The design and construction of an electric melting furnace as used in conjunction with a welding transformer; (2) the production of alloy steel by crucible melting; (3) a paraffin-fired muffle for mould baking and the heat-treatment of castings; and (4) the establishment of mild-steel castings production by " Thermit." Of particular interest in this section is the application of exothermic feeding sleeves for investment moulds. The third section deals with a selection of the castings produced.

" Une Fonderie à cire perdue en Afrique du Sud," par J. Steele (membre de l'Institut des Fondeurs Britanniques). (Mémoire d'échange de la Section Sud-Africaine de l'Institut des Fondeurs Britanniques).

Le mémoire relate la fondation de la première fonderie à cire perdue de l'Afrique du Sud, au cours des cinq années qui séparent les premiers essais de la période actuelle de pleine production. Le stade préliminaire est brièvement esquissé dans l'introduction, puis le mémoire composé de trois chapitres commence par le premier intitulé " Méthode et personnel," qui donne un exposé de la méthode utilisée et une description du personnel qui l'applique. Pour surmonter les difficultés dues au délais de livraison de matériel étranger, de même que celles résultant de considérations économiques, certains appareils durent être construits sur place, et des procédés spéciaux adoptés. Le second chapitre " Procédés," traite de ce sujet, et passe en revue : (1) l'étude et la construction d'un four de fusion utilisant un transformateur de machine à souder; (2) l'élaboration de l'acier dans un creuset; (3) l'utilisation d'un four chauffé au pétrole pour le traitement thermique des pièces et des moules; et (4) la production de pièces d'acier doux par le procédé " Thermit." L'utilisation d'un entonnoir de coulée en matière exothermique est particulièrement intéressante. Le troisième chapitre donne une description de pièces coulées dans la fonderie.

" Eine Kundengiesserei für Präzisionsguss in Südafrika," von J. Steele (Mitglied) (Austauschvortrag des südafrikanischen Zweiges des Institute of British Foundrymen).

Eine Präzisionsgiesserei für Kundenguss in Südafrika. Inhaltsangabe: Der Vortrag beschreibt die Errichtung der ersten industriellen Präzisionsgiesserei in Südafrika. Der Zeitraum von den ersten Versuchen bis zur heutigen Vollerzeugung erstreckt sich auf 5 Jahre. In der Einleitung werden die Anfangsstadien der Giesserei kurz beschrieben, worauf der Hauptteil des Vortrages in drei Abschnitten folgt. Der erste Abschnitt " Verfahren und Personal " gibt eine Ubersicht über das " Wachsverfahren " und dem damit hergestellten Präzisionsguss. Um die durch verspätete Belieferung der von Ubersee bestellten Einrichtung entstandenen Schwierigkeiten

zu überwinden, aber auch aus wirtschaftlichen Gründen, wurden gewisse Teile der Einrichtung selbst hergestellt und ein besonderes Verfahren eingeführt, das im 2. Abschnitte ausführlicher beschrieben wird. Hiezu gehören insbesondere: (1) *Entwurf und Konstruktion eines elektrischen Schmelzofens der in Verbindung mit einem Schweisstransformator arbeitet;* (2) *Erzeugung von Legierungsstahl durch Schmelzen im Tiegel;* (3) *Eine Paraffin geheizte Muffel zur Trocknung der Formen und zur Wärmebehandlung der Abgüsse; und* (4) *Herstellung von kohlenstoffarmen Stahlabgüssen mit dem "Thermit" verfahren. Von besonderem Interesse in diesem Abschnitte ist die Anwendung exothermer Steigereinsätze für Präzisionsgussformen. Der dritte Abschnitt befasst sich mit einer Auswahl der erzeugten Abgüsse.*

Paper No. 1135: "The Foundry Industry in Australia," by A. W. Silvester (Australian Branch Exchange Paper).

MR. A. W. SILVESTER, who will present the official Australian (Victoria) branch Exchange Paper, holds the position of materials engineer with Repco, Limited, Melbourne, and has for the past thirteen years been closely associated with the manufacture of automotive parts. A member of the American Foundrymen's Society and the local Institute of Metals and the Institute of Management. Mr. Silvester joined the Council of the former Institute of Australian Foundrymen, Victoria division in 1948. He was president from 1950 to 1952, and it was during his term of office that plans were made for the amalgamation with the Institute of British Foundrymen. Since this amalgamation, he has been appointed branch representative to the Council of the Institute. At the American Foundrymen's Convention held in St. Louis in 1949, Mr. Silvester read a Paper on "Secondary Graphitization of Cast Iron by Heat-treatment," which was then the official exchange paper from Australia.

This paper is a description of the post-war foundry industry in Australia. The industry of this country gained a tremendous upsurge of manufacturing technique during world war II, but it has been during the post-war period that the industry has expanded to meet the demands of the market to absorb labour, and to produce a quality casting at a competitive price. The paper is divided broadly into four chapters—"Australia To-day"; "Basic Material and Power Resources"; "The Foundry Industry"; and "Australia To-morrow." Since the foundry industry is a section of the engineering industry, which, in turn, is a part of secondary industry, it is important to relate the foundry industry to the basic structure and economy of the country. This is the theme of the first section, which covers the subjects of population, value of production, transport, etc. In some instances, it will be shown that the basic structure of the country has directly affected the industry and its mode of operation. The title of the second section is self-explanatory. The quality and price of raw materials have an important bearing on foundry techniques and operation, and it is shown that generalizations on foundry practice are often misleading, unless all the factors of fuel, metal, sand and refractories are clearly known. The section headed "Foundry Industry" is a description of typical foundry conditions. The degree of technical supervision in the industry is still very low and urgent steps are being taken to train suitable men for this work. The jobbing moulder is dying out and is being replaced by machine moulders, which is a serious problem the industry has to face. Finally, "Australia To-morrow" is a short section outlining some of the known plans of national and private development which will directly or indirectly promote the growth of the foundry industry.

"L'industrie de la Fonderie en Australie," par A. W. Silvester, (membre de l'Institut des Fondeurs Britanniques). (Mémoire d'échange de la Section Australienne de l'Institut des Fondeurs Britanniques).

Ce mémoire donne une description de l'industrie de la fonderie dans l'Australie d'après-guerre. L'industrie a vu ses techniques progresser à pas de géant pendant les années de guerre, mais c'est depuis la fin des hostilités que son expansion lui a permis de satisfaire aux exigences de la clientèle. Après avoir absorbé une main d'oeuvre disponible, elle peut maintenant couler des pièces de qualité à des prix raisonnables. Le mémoire se compose de quatre chapitres principaux: "L'Australie d'aujourd'hui," "Matières Premières et Sources d'Energie," "L'Industrie de la Fonderie," et "L'Australie de demain." La fonderie étant une branche de l'industrie mécanique dont beaucoup d'autres industrie dépendent, il convient de la considérer en fonction de la structure du pays et de son climat économique. C'est ce que se propose l'auteur dans le premier chapitre, qui englobe les problèmes de démographie, de production et de transport. On verra comment la structure du pays a parfois directement influé sur les méthodes de production de l'industrie. Le second chapitre traite des matières premières et des sources d'énergie. La qualité et le prix des matières premières ont une influence considérable sur les techniques de la fonderie, et les généralisations concernant ces techniques sont dangereuses si tous les éléments qui entrent en ligne de compte ne sont pas suffisamment connus: combustibles, métaux, sables et réfractaires. "L'Industrie de la Fonderie" est une description des conditions actuelles de la fonderie. Les cadres techniques sont encore très rudimentaires, mais de gros efforts sont accom-

plis pour former des techniciens compétents. Le mouleur à la main disparait graduellement, mais son remplacement par le mouleur sur machine pose à l'industrie de sérieux problèmes. Enfin " L'Australie de demain " est un court chapitre qui donne un aperçu des plans de développements, tant sur le plan national que sur le plan privé, qui conditionneront directement ou indirectement l'avenir de l'industrie de la fonderie.

" Die Giessereiindustrie Australiens," von A. W. Silvester (Mitglied). (Austauschvortrag des australischen Zweiges des Institute of British Foundrymen).

Inhaltsangabe: Dieser Vortrag beschreibt die Giessereiindustrie Australiens, welche einen ungeheuren Aufschwung ihrer Erzeugungsmethoden während des 2. Weltkrieges erzielte, aber sich erst in den Nachkriegsjahren so ausweitete, dass sie imstande war den Anforderungen des Marktes nachzukommen, Arbeitskräfte zu absorbieren und Qualitätsguss zu Konkurrenzpreisen herzustellen. Der Vortrag hat vier Unterteilungen: " Das heutige Australien," " Rohstoffe und Kraftquellen," " Die Giessereiindustrie " und " Das Australien der Zukunft." Da die Giessereiindustrie ein Teil der Maschinenindustrie ist, welche selbst einen Teil der Weiterverarbeitungsindustrie bildet, ist es wichtig, die Giessereiindustrie in ihrer Beziehung zum allgemeinen Aufbau und zur Wirtschaft des Landes aufzuzeigen. Dies ist das Thema des ersten Teiles, welcher sich auf Bevölkerung, Erzeugungswert, Transport usw. bezieht und in einigen Fällen zeigen wird, wie die allgemeine Struktur des Landes die Giessereien und ihre Arbeitsweisen direkt beeinflusst hat. Der zweite Teil, der sich auf Rohstoffe und Kraftquellen bezieht, bedarf keiner weiteren Erklärung, Güte und Kosten der Rohstoffe sind von weittragender Bedeutung für Giessereiverfahren und Arbeitsmethoden und es wird gezeigt, dass Verallgemeinerungen über Giessereipraxis oft irreführend sind, wenn nicht alle besonderen Umstände hinsichtlich Brennstoffen, Metallen, Formsand und feuerfesten Steinen bekannt sind und in Betracht gezogen werden. Der dritte Teil " Die Giessereiindustrie " ist eine Beschreibung der vorherrschenden Giessereizustände. Das Ausmass technischer Ueberwachung ist noch sehr gering und es werden besondere Anstrengungen gemacht, geeignete Männer für solche Aufgaben heranzubilden. Die gelernten Former sterben aus und werden durch angelernte Formmaschinenarbeiter ersetzt, was der Industrie grosse Probleme zur Lösung aufgibt. Der letzte Abschnitt " Das Australien der Zukunft " ist ein kurzer Abriss der bekannten Pläne für nationalen und privaten Ausbau, welche direkt oder indirekt das Wachsen der Giessereiindustrie förden werden.

Paper No. 1136:

" Ingates " (Report of Technical Sub-committee T.S.24).

SUB-COMMITTEE T.S.24 of the Institute of British Foundrymen was formed in December, 1947, with the following terms of reference:—" To study the influence of the shape and size of ingate and runner systems on the condition of flow of metal into a mould." Constitution of the sub-committee: F. J. McCulloch (Chairman), F. Butters, D. Carrick, F. Cousans, F.I.M., B. Edwards, M.I.MechE., G. Foster, G. L. Harbach, A. G. Harrison, V. Kondic, B.Sc., Ph.D., D. Killingworth, B.Sc., F.I.M., G. Martin, B.Sc., Ph.D., A.M.Mech.E., D. W. Spence, G. L. Turner, B.Sc., G. Lambert, secretary. Others who have served for periods during the long life of the Committee are W. Barnes (the original chairman), R. C. Shepherd, who was chairman for several years, D. W. Berridge, A. I. Donaldson, F. J. Hoult, H. W. Keeble, A. B. Lloyd, B.A., K. H. Wright and D. Worth, B.Sc.

The sub-committee's work on gating systems summarizes the various factors affecting flow through the channels carrying the metal to the casting. The initial experiments and an exhaustive study of the literature convinced the sub-committee that molten metal at pouring temperatures behaves like a normal fluid and that, therefore, the laws of hydraulics could be applied. From these laws, equations have been derived relating the rate of flow to the shape and size of the gating system. Hydraulic loss-coefficients for use in these equations were determined by practical experiments on the foundry floor for the normal components of gating systems and a method is described for determining further loss-coefficients for other components. The validity of the equations and coefficients was established by numerous tests on small and medium-size castings.

The Report does not lay down any empirical rules for gating but rather provides basic information so that once the foundryman has decided what he requires of the gating system, i.e., the number and position of ingates, the mould filling time, the speed of entry at the ingates and whether it is to be pressurized or non-pressurized, the information and equations given in the Report will enable the total ingate size and the dimensions of the remainder of the gating channels to be determined. The gating system can then be expected to give maximum yield, whilst still meeting the conditions imposed.

" Alimentation des pièces de Fonderie." (Mémoire de la Sous-Commission T.S.24 du Conseil Technique de l'Institut des Fondeurs Britanniques).

Le mémoire de la Sous-Commission chargée de l'étude de l'alimentation des pièces résume les différents facteurs qui interviennent dans l'écoulement

du métal au travers des passages qui le conduisent à la pièce. Les essais préliminaires, et une étude approfondie des travaux antérieurs, persuadèrent la Sous-Commission que le métal en fusion aux températures de coulée, se comportait comme un fluide ordinaire, et que, par conséquent, les lois de l'hydraulique pouvaient être appliquées à un tel écoulement. Ces lois ont conduit à des équations établissant un rapport entre le débit d'une part, et la forme et les dimensions des passages d'écoulement d'autre part. Les coéfficients hydrauliques de pertes de charge furent obtenus par des expériences pratiques de fonderie pour des systèmes de coulée types, et une méthode de détermination de ces coéfficients pour n'importe quel autre système de coulée, a été mise au point. La valeur des équations et des coéfficients a été vérifiée par de nombreux essais sur des pièces de petites et moyennes dimensions.

Le mémoire ne donne pas de lois empiriques concernant l'alimentation des pièces, mais il fournit des informations qui permettent au fondeur des déterminer les dimensions des attaques et des canaux d'alimentation, une fois qu'il a choisi le procédé d'alimentation à employer (c'est à dire le nombre et l'emplacement des attaques, la forme de la coulée, le temps de remplissage du moule, la vitesse de coulée, la pressurisation éventuelle de la coulée.) L'attaque donnera alors les meilleurs résultats compatibles avec les conditions requises par le fondeur.

" Eingüsse und Anschnitte," (Bericht des Unterausschusses T.S.24 des technischen Komitees).

Die Arbeit des Unterausschusses, der sich mit Anschnittmethoden befasste, zählt die verschiedenen Faktoren auf, die das Fliessen des flüssigen Schmelzgutes beeinflussen, welches durch Eingusstrichter und Abläufe über die Anschnitte in das eigentliche Gusstückvolumen einfliesst. Einleitende Versuche und ein umfassendes Studium der Literatur überzeugten den Unterausschuss, dass auf Giesstemperatur gebrachtes flüssiges Metall sich wie eine normale Flüssigkeit verhält und dass daher die Gesetze der Hydraulik angewendet werden könnten. Von diesen Gesetzen wurden Gleichungen abgeleitet, welche die Giessgeschwindigkeit mit der Form und dem Ausmasse des Einguss-und Vorlaufsystems in Beziehung bringen. Hydraulische Verlustkoeffizienten zur Anwendung in diesen Gleichungen wurden durch praktische Versuche in der Giesserei selbst für die üblichen Bestandteile des Eingusslaufes festgestellt und es wird ein Verfahren beschrieben um weitere Verlustkoeffizienten für andere Teile der Ein-und Durchleitung des flüssigen Schmelzgutes zu bestimmen. Die Giltigkeit der Gleichungen und Koeffizienten wurde durch zahlreiche Versuche an kleinen und mittelgrossen Abgüssen erprobt. Der Bericht vermeidet es eine empirische Regel für Eingusstechnik aufzustellen, sondern zieht es vor, grundlegende Information zu geben, so dass der Giessereifachmann, sobald er entschieden hat, was er vom Anschnittsystem erwartet, d.h. Anzahl und Lage der Eingüsse, Länge der zur Füllung der Gussform nötigen Zeit (Formenfüllzeit), Durchflussgeschwindigkeit, Fallhöhe des durch die Eingüsse fliessenden Metalls und ob Druckguss oder nicht, in der Lage ist, mit Hilfe der im Bericht gegebenen Information und den Gleichungen das Gesamtzulaufsystem und die Ausmasse der übrigen Sammelläufe zu bestimmen. Unter diesen Umständen kann man dann von der Anschnittmethode die maximale Ausbeute erwarten und dabei doch den gestellten Bedingungen entsprechen.

Paper No. 1137: " Gases in Cast Iron," by H. Morrogh (An account of the British Contribution to the Study of this Problem submitted on behalf of the Joint Committee of the Institute of British Foundrymen and the British Cast Iron Research Association).

THE GASES IN CAST IRON committee, jointly representing the Institute of British Foundrymen and the British Cast Iron Research Association, held its first meeting in September, 1946. The terms of reference of the committee were:—" To explore the gas content of cast iron in relation to pig-iron and the remelting procedure." Since the first meeting, considerable work has been carried out, and it was thought opportune at this stage to issue

The various anomalies alleged to be due to variations in the gaseous-element content of cast irons have been reviewed, and the difficulties in the determination of the gaseous-element content have been discussed. Many of the claims made for the influence of the gaseous elements in cast irons are not supported by actual evidence of variation in gaseous-element content. A Joint Committee of the Institute of British Foundrymen and the British Cast Iron Research Association has made an exhaustive examination of the techniques for the determination of the gaseous elements in cast iron and for the sampling of cast irons for these determinations. The need for this type of co-operative work is emphasized. Many of the results reported in the literature are of doubtful value because the methods used have not been subjected to this type of critical co-operative investigation.

a report on behalf of the Joint Committee so that foundrymen might learn more of the problems associated with the work of this nature, of the progress made, and of the effort required in the future. The present membership of the Joint Committee is: H. Morrogh (chairman), British Cast Iron Research Association; B. B. Bach, British Cast Iron Research Association; W. Y. Buchanan, John Lang & Sons, Limited, Johnstone, near Glasgow; J. V. Dawson, British Cast Iron Research Association; T. Evans, University College of South Wales and Monmouthshire, Department of Metallurgy and Fuel Technology, Cardiff; N. Gray, Guest, Keen, Baldwins Iron & Steel Company, Limited, Port Talbot; H. G. Hall, Castings, Limited, Walsall; Dr. R. V. Riley, Staveley Iron & Chemical Company, Limited, Chesterfield; H. A. Sloman, National Physical Laboratory, Teddington; L. W. L. Smith, British Cast Iron Research Association; G. E. Speight, R.T.S.C., Central Research Laboratories, Aylesbury; K. H. Wright, C. Akrill, Limited, West Bromwich; and G. Lambert, secretary, Institute of British Foundrymen.

The vacuum-fusion method has been chosen for the determination of oxygen and nitrogen, but a chemical method has also been used for the determination of the latter. The vacuum-fusion method is not ideally suited to the determination of hydrogen and an improved vacuum-heating technique has been developed. The sampling of cast iron for gaseous-element determinations is shown to be very important. Differing results for oxygen content may be obtained according to the position of the sample in sand-cast samples. Small chill-cast samples are shown to give reproducible results for oxygen, nitrogen and hydrogen using the vacuum-fusion process. Using small chill-cast samples, metal has been sampled at a number of works using a wide variety of melting units and melting practice. These results are presented in detail.

The influence of oxygen on chilling tendency and on the annealability of malleable iron has been studied. It has been shown that oxygen itself does not influence the chilling tendency or the annealability. The oxygen may appear in some circumstances to have a chilling tendency due to its combining with aluminium which has a graphitizing influence. The influence of nitrogen in cast iron has been studied in detail; it is shown to be a carbide-stabilizing element, the effect of which can be neutralized by small additions of aluminium. The influence of the amount of steel scrap on the gaseous-element content of cupola melted metal has been studied.

A satisfactory and very sensitive technique for the determination of hydrogen in cast-iron samples has been evolved, but much further work is required on sampling techniques for hydrogen estimations. The influence of carbon content on the solubility of hydrogen in iron/carbon alloys at temperatures up to 1,000 *deg. C. has been studied.*

" Les gaz de la fonte," par H. Morrogh, (membre de l'Institut des Fondeurs Britanniques). (Mémoire de la Commission mixte de l'Institut des Fondeurs Britanniques et de la British Cast Iron Research Association).

L'auteur passe en revue les différentes anomalies de la fonte, généralement attribuées à la variation des éléments gazeux, et souligne la difficulté que présente leur dosage. Dans bien des cas l'influence de ces éléments n'est pas celle que l'on croit, ainsi qu'il a pu être démontré en faisant varier leur concentration. Une Commission mixte de l'Institut des Fondeurs Britanniques et du British Cast Iron Research Association, a étudié d'une manière approfondie les procédés d'analyse des gaz contenus dans la fonte, de même que la façon de sélectionner les échantillons destinés à être analysés. L'auteur insiste sur l'importance d'une telle collaboration : beaucoup de résultats publiés dan la littérature technique sont d'un intérêt douteux, car ils n'ont pas été soumis à une semblable étude critique faite en collaboration.

La méthode de coulée sous vide a été choisie pour la détermination de l'oxygène et de l'azote; celui-ci a également été analysé par voie chimique. La coulée sous vide n'est pas satisfaisante pour le dosage de l'hydrogène, aussi un procédé de réchauffage sous vide a-t-il été mis au point. L'échantillonnage de la fonte destinée à l'analyse des éléments gazeux s'est révélé très important. On peut obtenir des teneurs en oxygène très variables selon la position de l'échantillon, dans le cas d'éprouvettes coulées au sable. De petites éprouvettes coulées en coquille sous vide, au contraire, donnent des résultats très cohérents pour l'oxygène, l'azote et l'hydrogène. Cette méthode a été utilisée pour couler des éprouvettes dans des fonderies utilisant des fours et des procédés de fusion très différents. Les résultats sont présentés en détail dans le mémoire.

L'influence de l'oxygène sur la tendance à la trempe, et sur la faculté de recuit de la fonte malléable a été étudiée, et il a été démontré que l'oxygène en lui-même n'a aucune action sur ces facteurs. Dans certains cas, cependant, l'oxygène peut sembler favoriser la tendance à la trempe, mais cela provient de sa combinaison avec de l'aluminium qui provoque une formation de graphite. L'azote, dont l'influence a été étudiée en détail, est un élément de stabilisation du carbure, dont l'effet peut être neutralisé par de faibles additions d'aluminium. Le mémoire décrit ensuite l'influence de la quantité de rebuts d'acier introduite dans le cubilot, sur la teneur en gaz de la fonte obtenue.

Un procédé très sensible de dosage de l'hydrogène a été mis au point, mais il faut encore approfondir les procédés d'échantillonnage. Enfin l'influence de la teneur en carbone sur la solubilité de l'hydrogène dans les alliages fer/carbone a été étudiée jusqu'à une température de 1,000° *centrigrade.*

"Gase im Gusseisen," von H. Morrogh (Mitglied). (Bericht des gemeinsamen Gaskomitees des Institute of British Foundrymen und der British Cast Iron Research Association).

Es wird ein Überblick über die verschiedenen Abweichungen vom normalen Verhalten des Gusseisens gegeben, welche angeblich von den Schwankungen der Mengen gasförmiger Bestandteile im Gusseisen abhängen und es werden die Schwierigkeiten besprochen, die sich deren experimenteller Bestimmung entgegenstellen. Viele der zahlreichen Behauptungen hinsichtlich des Einflusses gasförmiger Bestandteile im Gusseisen finden keine Unterstützung durch tatsächlichen Beweis von Schwankungen im Gasgehalt. Ein gemeinsamer Ausschuss des Institute of British Foundrymen und der British Cast Iron Research Association hat eine ausgedehnte Untersuchung der Methoden zur Bestimmung gasförmiger Bestandteile im Gusseisen vorgenommen und die Musternahme für solche Gusseisenproben untersucht. Es wird die Notwendigkeit solcher Zusammenarbeit betont, da viele in der Literatur veröffentlichten Ergebnisse von zweifelhaftem Werte sind, weil die angewandten Methoden keiner solchen auf gemeinsamer Arbeit aufgebauten Kritik unterzogen waren.

Zur Bestimmung von Sauerstoff und Stickstoff wurde die Methode des Vakuumschmelzens gewählt, jedoch wurde auch eine chemische Methode zur Stickstoffbestimmung herangezogen. Da die Vakuumschmelz-methode zur Wasserstoffbestimmung nicht sehr geeignet ist, wurde ein verbessertes Vakuumheizverfahren entwickelt. Es wird gezeigt, dass die Art der Musternahme von Gusseisenproben zur Bestimmung der gasförmigen Bestandteile von grosser Wichtigkeit ist; so können ganz verschiedene Werte für den Sauerstoffgehalt gefunden werden, je nach der Lage des aus dem sandgegossenen Probestück entnommenen Musters. Hingegen zeigen in Kokille gegossene Proben weiderholbare Ergebnisse für Sauerstoff, Stickstoff und Wasserstoff unter Anwendung des Vakuumschmelzverfahrens. Unter Benützung solcher kleiner in Kokille gegossener Proben wurden Gusseisenmuster in einer Reihe von Werken gezogen, die eine Vielfalt von Schmelzeinheiten und Schmelzmethoden verwenden. Die so erhaltenen Resultate werden in Einzelheiten gegeben.

Es wurde der Einfluss von Sauerstoff auf die Neigung zu Abschreckung und auf die Normalisierung von Temperguss untersucht, jedoch zeigte Sauerstoff keinen Einfluss in beiden Fällen. In gewissen Fällen scheint Sauerstoff eine Abschreckwirkung zu zeigen, die auf seine Vereinigung mit Aluminium zurückzuführen ist, welch letzteres graphitfördernd ist. Der Einfluss von Stickstoff im Gusseisen wurde eingehend studiert, er wirkt sich Karbid-stabilisierend aus, diese Wirkung kann durch kleine Zusätze von Aluminium aufgehoben werden. Der Einfluss der zugesetzten Stahlschrotmenge auf den Gasgehalt von im Kupolofen geschmolzenem Eisen wurde studiert.

Es wurde eine zufriedenstellende und sehr empfindliche Methode zur Bestimmung von Wasserstoff in Gusseisenproben entwickelt, doch ist noch viel weitere Arbeit zu unternehmen, um ein einwandfreies Verfahren der Musterziehung für die Wasserstoffbestimmung zu besitzen. Schliesslich wurde der Einfluss des Kohlenstoffgehaltes auf die Löslichkeit von Wasserstoff in Eisen-kohlenstofflegierungen bei Temperaturen bis zu 1000° C. untersucht.

IBF Vice-presidents Nominated

Senior Vice-president

H. J. V. WILLIAMS, who has been nominated by the Council for the office of senior vice-president for the year 1955-56, is joint managing director of John Williams & Sons (Cardiff), Limited. Mr. Williams was educated at Leys School, Cambridge, followed by part-time study at Cardiff Technical College. He has been prominently associated in his work for his Company with the development of alloy and high-duty irons. For two years, Mr. Williams was president of the Wales and Monmouthshire branch of the Institute, and has served for several years as branch delegate to the Council.

Junior Vice-president

JOHN BLAKISTON, who has been nominated for the office of junior vice-president for the year 1955-56, is in business as an engineer and foundry consultant. In addition to his present work as a consultant, Mr. Blakiston is a director of W. Richards & Sons, Limited, and the Sandholme Iron Company, Limited. He joined the Institute in 1929 and was subsequently elected to the Council of the Middlesbrough branch. Following his transfer to the West Riding branch in 1936, he became one of their members of Council and was branch president in 1944-45.